THE ENGINEERING CONSTRUCTION WEEKLY

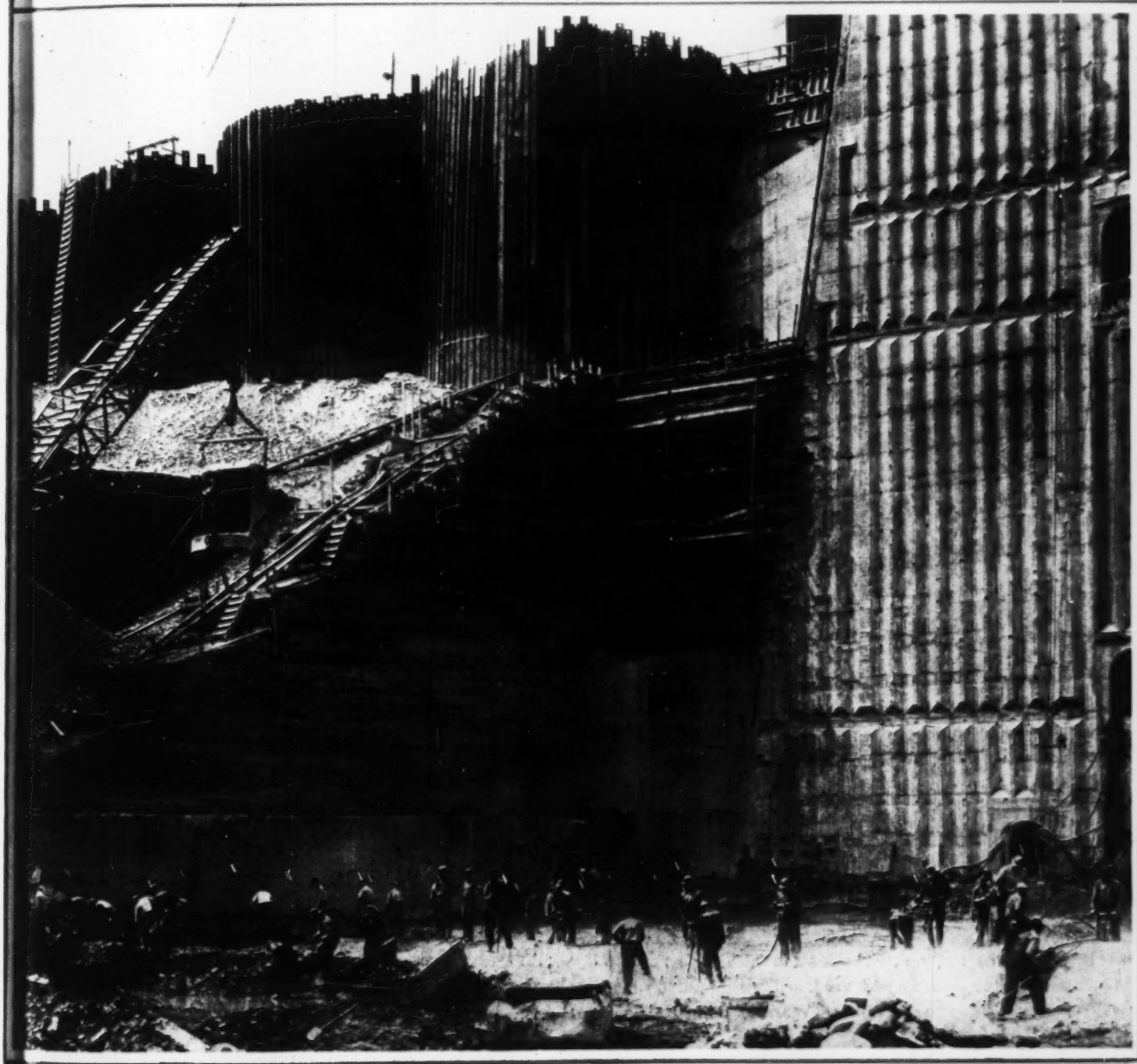
McGRAW-HILL PUBLISHING COMPANY, INC. · TWENTY-FIVE CENTS. FIVE DOLLARS PER YEAR

Engineering Library

JUL 6 1937

Engineering NEWS-RECORD

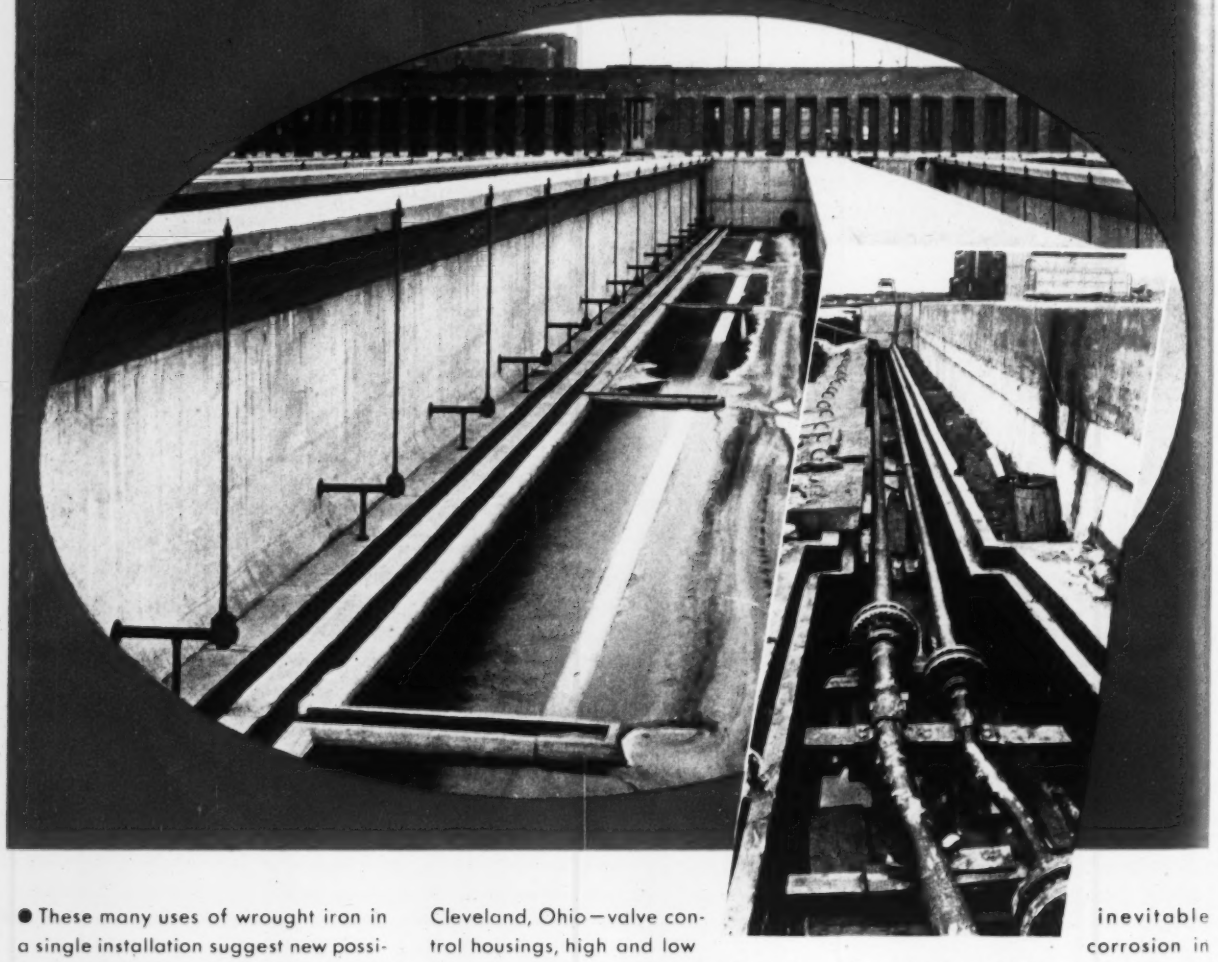
July 1, 1937



BRIDGES · IRRIGATION · FLOOD CONTROL · FOUNDATIONS · DAMS

HIGHWAYS · WATERWORKS · STREETS · SEWERS

Over 15 Services for BYERS WROUGHT IRON in Cleveland Sewage Treatment Plant



● These many uses of wrought iron in a single installation suggest new possibilities of economy in sanitary systems. The sulphides, nitrates, chlorides, phosphates and carbonates—both gaseous and liquid—that are common to sewage treatment, make short work of ordinary pipe. When it comes to this and many other types of corrosive service, no other material is comparable to wrought iron for long life and economy. Wrought iron not only resists corrosion, but it withstands vibratory stresses.

Note the many services for which Byers Wrought Iron was used in the Easterly Sewage Treatment Works, Cleveland, Ohio—valve control housings, high and low pressure steam heating supply and returns, hot and cold water lines under 3", oil lines, aeration control piping, gas lines, meter drainage and vent lines 2" and under, sludge and sludge heating lines, well casings, railings, underground and other lines subject to vibratory stress.

Would you like us to help you determine the best materials to resist the inevitable corrosion in the projects on which you are now working? Our laboratory and Field Engineers are at your service. Give us a brief description and also ask for the illustrated, technical bulletin just published, "Wrought Iron in Sanitary Systems."

A. M. Byers Company. Est. 1864. Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

BYERS GENUINE WROUGHT IRON

Tubular and Flat Rolled Products

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

The Contractor and Public Construction

LAST WEEK, inspired by the comment of a reader, this page told why it favors a consistent program of useful public construction. It deferred until this issue discussion of another point implied by the reader's misgiving that it seems to be "too much in favor of more profit for more contractors at more government expense."

If this writer has a preference for public construction by contract rather than by the direct employment of day labor, it is only because of his preference for the principle of private enterprise as opposed to socialization.

So long as we continue to profess an economy based on private enterprise, it seems but consistent to ask that we continue to handle the largest possible share of both public and private construction in accordance with that principle. Contractors are to the construction industry what industrial and business organizations are to manufacturing and trade. They are the embodiment of private enterprise as applied to construction.

Under certain conditions and in exceptional cases, sound policy may require that a government department, as well as a railroad or a public utility, carry on construction with its own forces rather than by the competitive award of contracts. But such a course should be the exception rather than the rule.

IN EVERY CASE, such a decision should be supported by reasons as cogent as those which might be invoked to justify government operation of factories to manufacture its construction materials, lead pencils, motor cars, uniforms and shoes for its troops. Such an invasion of the manufacturing industries, however well justified, would be recognized at once as a radical departure from the basic principles of our economy. But it should be seen just as clearly that invasion of the construction industry by public operation is, in fact, an equally real departure from those principles.

Whatever risk may be involved when government enters the construction business under normal conditions, infinitely greater hazards prevail when public construction is taken away from the organized construction industry and turned over to welfare agencies, the paramount objective of which is the making of more jobs rather than the most efficient expenditure of public funds.

THE CONDUCT OF CONSTRUCTION is just as specialized a function as is any other industrial process. Its efficient conduct calls for comparable skill, experience, resources and responsibility. The incentives and qualities required for good management are best developed under the same conditions that prevail in other industries. Sound investment of public funds in any form of public works involves just as real a need for efficient management as does a similar investment in any other form of enterprise. When the people invest their funds in public works they are entitled to the same efficiency that they expect in any other field of endeavor. If, then, the construction industry is to be elbowed aside to provide scope for highly questionable experiments in social welfare, the public, which must pay for its public works, should understand fully what that procedure is going to cost, not only in current expenditures but also in long term injury to one of its basic industries.

No, all this is not a matter of "more profit for more contractors." The contractors and their profit are quite incidental. The question is whether the American people are to retain a construction industry that is based on competitive private enterprise in common with the rest of the industrial structure, or whether they are to have imposed upon them, in the name of social welfare, a veiled but none the less effective socialization of the construction function, with all that it implies to the millions who now find in it employment for their labor and their capital.

Willard Chevalier

·ENGINEERING NEWS-RECORD·

Published every Thursday. Vol 119, No. 1. Price 25c per copy. Subscription, domestic, Canada, Mexico, Central and South American countries, $5 per year. All other countries, $9 a year or 36 shillings. Entered as second-class matter October 29, 1936, at the Post Office at Albany, N. Y., under the act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill New York" Member A.B.P. Member A.B.C.

Copyright 1937 by McGRAW-HILL PUBLISHING COMPANY, Inc.

Editorial and Executive Offices: 330 West 42d St., New York. Publication Office: 99-129 N. Broadway, Albany, N. Y. Branch Offices: 520 N. Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

JAMES H. McGRAW, JR., President — HOWARD EHRLICH, Exec. Vice President — JAMES H. McGRAW, Honorary Chairman
WILLARD CHEVALIER, Vice President — B. R. PUTNAM, Treasurer — D. C. McGRAW, Secretary

TABLE OF CONTENTS—See Page 25

HAULS MORE-SAVES MORE

THE TRUCK GMC OF VALUE

GMC design is the result of cumulative experience—from decades back. For instance, GMC frames—the backbone of the load—are metallurgically strong without being uselessly heavy; GMC engines have a high ratio of pulling power of capacity rating; GMC axles, springs, wheels and brakes are preponderantly strong! And GMC drivers are protected by all steel cabs affording wide angle driving vision and unusual comfort features including healthful ventilation. Besides this, GMC's are smart looking. These features save upkeep cost, increase advertising value, pyramid profits—*especially with GMC prices so low!*

Time payments through our own Y. M. A. C. Plan at lowest available rates

GENERAL MOTORS TRUCKS & TRAILERS

GENERAL MOTORS TRUCK & COACH • DIVISION OF YELLOW TRUCK & COACH MANUFACTURING COMPANY • PONTIAC, MICHIGAN

· ENGINEERING NEWS-RECORD ·

McGRAW-HILL PUBLISHING COMPANY, INC.

Editorial and Executive Offices: 330 West 42nd Street, New York · Publication Office: 99-129 North Broadway, Albany, N. Y.

F. E. SCHMITT, *Editor* WILLARD CHEVALIER, *Vice-President*

Copyright 1937

VOL. 119 *JULY 1, 1937* NO. 1

THIS WEEK AND NEXT

SERIOUS INFLOW to the cofferdam at Grand Coulee developed early in March threatening for a time to flood the whole excavation. The initial work of checking the flow was described in our issue of April 22. An article on this issue completes the report of the contractor's remarkable operation.

No quality of good concrete is more important than workability, and none is more elusive as to definition and preordained attainment. Edw. W. Scripture attempts in this issue a rational approach to workability which is necessary if fruits of the laboratory are ever to be translated into tools for the field man.

Nowhere in the country is the menace of sudden floods worse than in the suburban communities between Los Angeles and the foothills. What has been done in storage reservoir construction and channel improvement is the subject of two articles, the first of which is in this issue.

Control of asphalt mixing and placing in Detroit has been placed on a basis of great accuracy without sacrifice of efficiency. In this issue the complete operation from mixing plant to finished paving is outlined.

Water storage tanks composed of sand and gravel basins, introduced more than a century ago in the semi-desert regions of the Southwest, are reported as still providing a dependable source of water.

Since March, 1936, when record-breaking floods ran roughshod over New England bridges, a $13,000,000, reconstruction program has been underway. Large and small, important and secondary bridges are included. Next week a survey and analysis of this program will be published, followed in succeeding weeks by articles that get down to the details.

		PAGE
The Week's Events		1
Reader Comment		9
Editorials		10
Pictures in the News		12
Contractor Wins River Battle *(Cofferdams, Sheetpiling, Fill solidification)*		13
Concrete Workability *(Concrete, Masonry, Admixtures)*	EDW. W. SCRIPTURE	17
Checking Torrential Floods *(Flood control, Channel construction)*		22
Controlled Asphalt Paving *(Street paving, Asphalt mix control)*	CHARLES L. SHATTUCK	25
Engineering Institute Semicentennial *(Precast concrete, Winter construction, Transport)*		29
Steel Baffles Stop Slide *(Highway construction, Fill stabilization)*	G. H. ALLEN	32
Field and Office Notes		34
Desert Water Tanks *(Water supply, Subsurface storage)*	GLENTON G. SYKES	36
The Week's Events (Continued)		38
Current Labor and Material Prices	*Adv.page*	28
New Aids to Construction	*Adv.page*	32
Construction Reports	*Adv.page*	43

THE COVER PICTURE shows the upstream, inner corner of the cofferdam at Grand Coulee. The concrete wall at the left is an emergency support for circular cells; at the right is the east face of a section of the dam.

Enduring strength for permanent buildings... low cost for temporary structures

Trafford Tile is extensively used in England's famous Wembley Stadium.

Trafford Tile

TRAFFORD TILE is a new siding material of advanced engineering design. Made of weather-resisting and fire-resisting asbestos-cement, it comes in sheet form and is ideally adapted for the walls of industrial buildings.

Economy, lighter weight, enduring strength... these have been engineered into Trafford Tile through the correct distribution of material. Its corrugations are scientifically shaped and spaced for extra rigidity.

Trafford Tile is a pleasing gray color, and gives the effect of Roman Tiling. Low cost application is a distinctive feature. The engineering staff of Keasbey & Mattison Company will gladly advise you on the various applications of this remarkable new material.

K&M best in asbestos

KEASBEY & MATTISON COMPANY AMBLER, PENNA.

THE WEEK'S EVENTS

Relief Bill Approved Continuing PWA

No appropriation for public works provided but PWA may spend revolving fund

Continuation of the Public Works Administration until June 30, 1939, is assured by the agreement of House and Senate conferees on the relief appropriation bill.

Although none of the relief money was allocated to PWA, the bill contained a provision extending the life of the agency, which was due to expire on June 30, 1937, and permitting it to convert bonds contained in its revolving fund into cash to finance further operations. Total expenditures during the two-year extension period are limited to $359,000,000.

For relief purposes, the bill appropriates $1,500,000,000 to be allocated at the discretion of the President, with a proviso that administrative expenses shall not exceed 5 per cent. Certain specialized agencies such as the National Resources Committee, however, are exempted from this limitation. A Senate amendment requiring the publication of the names of all administrative officers receiving over $1,000 per year was eliminated in conference.

Formal revocation by PWA of an order dated April 24 completed the restoration of that agency to the conditions under which it has functioned since 1934. The order in question had limited grants to 115 per cent of the amounts actually paid out for labor from relief rolls; from now on the grants will be calculated on the former basis of 45 per cent of the total cost of each project.

Inasmuch as PWA now has on file applications for about three times the amount of money available it is expected that additional allotments, before being approved by the President, will undergo a process of selection. While no official commitment has been made, informal assurances given to members of the PWA block in Congress indicate that primary attention will be given to the so-called "Moral obligation" projects on which local authorities have already carried out bond elections, constitutional amendments, and other legal proceedings in the expectation that PWA would furnish a 45 per cent grant. Also due for prompt consideration is a replacement program for over a thousand hazardous school buildings in all sections of the country.

• • •

Senate Increases Amount For Flood Control

Substantial increases in the amounts provided for flood control were approved by the Senate when, on June 23, it passed the War Department Appropriation bill carrying funds for both military and non-military activities during the coming fiscal year. The bill is now before a conference committee for the adjustment of differences between the House and Senate versions.

For the lower Mississippi flood control work, the Senate increased the House appropriation of $22,500,000 to $45,000,000 and, in addition, authorized the Corps of Engineers to incur future obligations up to $10,000,000.

To cover other flood control work throughout the country $60,000,000 was approved, as compared with $30,000,000 provided by the House, and additional contract authorizations of $38,000,000. In both cases the amount appropriated would be reduced by the amount of any allotments made from the relief fund for flood control purposes.

MAJOR NEWS

	Page
PWA Continued	1
Grand Lake-Big Thompson	1
Flood Control Increased	1
Steel Warehouse Falls	2
New Bonneville Bill	4
Wage Bill Hearings	5
Activated Sludge Suit	5
Hugh L. Cooper Dies	6
Wagner Housing Bill	7
Company-TVA Contract	8

Grand Lake-Thompson Project Approved

Senate approves $44,000,000 project for trans-mountain water diversion in Colorado

The Senate on June 24 passed and sent to the House a bill authorizing the construction of the $44,000,000 Grand Lake-Big Thompson trans-mountain diversion project in Colorado, a combined irrigation and power development that would divert 310,000 acre-feet annually through a 13-mile tunnel under the continental divide to provide a supplementary water supply serving 615,000 acres of irrigated land of which a large part is now suffering from lack of adequate supply.

Besides the tunnel, the system would comprise nine canals, five reservoirs, a diversion dam, two pumping plants, and a power plant for the initial installation, with the subsequent development of five additional power plants as the demand for energy develops.

The total cost chargeable to irrigation would be $24,666,079. For the initial power development, including the necessary transmission lines and other facilities, the cost is estimated at $7,036,693, which would be increased to $19,083,243 with full development. Initial generating installation would be 30,000 kw.; ultimate, 142,500, producing 360,000,000 kw.-hr. annually of firm power and 200,000,000 kw-hr. of saleable secondary power. All plants would be of the high-head type, varying from 225 to 1,125 ft.

The two pumping plants, both included in the initial development, would have a combined demand of 18,000 kw. The surplus power developed would be available for public distribution.

Planning of the project has been complicated by the necessity of providing for present and potential irrigation demands on the western side of the divide, from which the surplus water is being diverted, and by the necessity for protecting the scenic beauty of the Rocky Mountain National Park, beneath which the tunnel passes. The length of the bore has been increased 1.6 miles in order to bring both portals outside of the park.

Steel Warehouse Falls During Erection

Collapse of Los Angeles structure claimed due to inadequate bracing and improper bolting up

The steel framework of a warehouse being built in Los Angeles for the Pacific Nut Oil Co. collapsed without warning on June 23, killing two workmen and injuring five others.

Steel was being erected by the Atlas Scraper & Engineering Co., of Los Angeles. All steel was in the air at the time of the collapse and the crew was plumbing the building.

The building was 60 ft. high and covered an area of 150 x 300 ft. It consisted of 18 pyramid-type trusses about 50 ft. high and with a span of 100 ft. The Los Angeles County Building Department states that during erection no diagonal bracing was placed between trusses. Two cables restrained the structure to the north. There were no cables to the south. When the cables to the north were released, the structure collapsed, practically all the trusses at once. The men who were killed were on top and rode the steel down.

Negligence Charged

A coroners jury held that death was accidental and due to negligence on the part of parties in charge of construction work. A county building inspector, testifying at the inquest, stated that the building was lacking in proper bracing, and workmen testified that the day before the collapse the steel framework was as much as 5 in. out of line and that sections of the steel were held together with only one bolt, although there were holes for three.

Wide World Photo

FALLEN framework of a Los Angeles warehouse which collapsed during construction, June 23, causing the death of two men.

Two CPR Engineers Retire

P. B. Motley, engineer of bridges for the Canadian Pacific Railway, and J. W. Orrock, engineer of buildings for the line, retired on June 30 after 45 and 46 years' service, respectively, with the company. Mr. Motley will be succeeded by A. R. Ketterson, formerly assistant bridge engineer, and N. B. Reardon, assistant engineer of buildings, will take over Mr. Orrock's position.

Mr. Motley, born in India and educated in England, entered the service of the CPR in 1892, under P. A. Peterson, then chief engineer. He assumed the post from which he is now retiring in 1911, after occupying various positions in the engineering department. Mr. Motley has been responsible for some of the most famous bridges in Canada, including the famous Lethbridge Viaduct and the CPR Caughnawaga Bridge at Montreal. He has been active in the Engineering Institute of Canada.

Mr. Orrock joined the CPR in 1891 as a draftsman in the chief engineer's office, and, after service as chief draftsman, assistant engineer, division engineer at North Bay, and principal assistant engineer, he assumed his most recent post in 1924. He has supervised the construction of many of the CPR hotels.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY *ENGINEERING NEWS-RECORD*, IN JUNE, 1937

Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation*, $15,000; *other public works*, $25,000; *industrial buildings*, $40,000; *other buildings*, $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States June 1937	United States Six Months 1937	United States Six Months 1936	Canada
Public Works										
Waterworks	1,702	1,110	546	414	526	251	**4,549**	42,249	59,263	163
Sewerage	229	2,977	91	2,500	197	33	**6,126**	49,921	69,925	47
Bridges	1,354	5,454	6,742	1,313	1,405	1,052	**17,320**	62,136	85,154	412
Earthwork and waterways	58	3,000	895	115	7,787	1,459	**13,314**	50,262	77,457	504
Streets and roads	1,156	8,380	9,364	8,444	12,328	5,321	**44,993**	179,326	237,786	2,570
Buildings, public	988	11,525	2,405	7,434	6,328	1,458	**30,138**	155,992	239,136	294
Unclassified, public	152	8,854	96	680	1,098	1,001	**11,881**	65,284	54,024	513
Total public	**5,639**	**41,300**	**20,139**	**20,999**	**29,669**	**10,575**	**128,321**	**605,170**	**822,745**	**4,503**
Federal government (included in above classifications)	843	3,588	1,495	3,786	7,667	2,993	**20,372**	92,653	116,268	... ...
Private										
Bridges, private	.....	390	.....	.....	.....	.....	390	4,286	4,200	.....
Buildings, industrial	3,085	68,290	1,733	4,090	1,530	8,837	**87,565**	289,722	125,600	4,688
Buildings, commercial	2,225	37,336	3,300	3,125	1,162	966	**48,114**	243,311	102,476	.....
Unclassified, private	85	471	533	1,645	3,865	3,410	**10,009**	102,939	66,345	315
Total private	**5,395**	**106,487**	**5,566**	**8,860**	**6,557**	**13,213**	**146,078**	**640,258**	**298,630**	**5,003**
Total Engineering Construction										
June, 1937 (4 weeks)	**11,034**	**147,787**	**25,705**	**29,859**	**36,226**	**23,788**	**274,399**	.....	.....	**9,506**
May, 1937 (4 weeks)	12,528	131,004	19,914	28,259	25,090	18,217	**235,012**	.....	.....	18,207
June, 1936 (4 weeks)	11,806	64,433	23,167	26,483	41,261	16,773	**183,917**	.....	.....	11,092
Six Months, 1937	59,347	601,303	110,664	184,020	169,116	120,978	.....	1,245,428	.....	61,577
Six Months, 1936	78,721	347,407	141,063	194,840	220,513	138,831	.....	.....	1,121,375	44,456

THE CURRENT TREND

This week's news of contract volume and construction cost factors

June A Month of Rare Records

Contract awards in last four weeks at 149 per cent of same period last year is one of them.

The rare June days of poetic fame have nothing on the whole month of June, 1937. Not since 1930 has any June chalked up a total of construction contract awards that exceeds the $274,399,000 of the last four weeks, which is 49 per cent more than was recorded in June, 1936. And not since that same June, 1930, have private contracts been as much as the $146,078,000 of this June which represents a 168 per cent gain over the same month last year. Industrial buildings, whose June average was the highest in the past five years, contributed greatly to the private work showing.

The records, compared to June, 1936, continue: bridges up 22 per cent; industrial buildings up 352 per cent; commercial buildings up 87 per cent; streets and roads up 9 per cent, and unclassified construction up 20 per cent. There were losses too that differentiate this June from other Junes of recent years when public works were in the ascendency. Compared to June, 1936, last month witnessed a loss of 22 per cent in waterworks; 0.3 per cent in sewerage; 24 per cent in public buildings; and 1 per cent in earthwork and drainage.

Getting down to specific figures, June totals include $146,178,000, private; $107,949,000, state and municipal; and $20,372,000, federal; representing gains over May of 17, 10 and 78 per cent respectively. Summer thus is off to a good beginning, and only New England, in the territorial distribution of new work, failed to reflect the improvement, recording a loss of 12 per cent compared to May. In comparison with June, 1936, New England with a loss of 7 per cent is joined by the West of Mississippi section with a loss of 12 per cent. All other sections gained, the Middle Atlantic states reporting a 129 per cent increase.

New capital raised for construction in June was not unusually impressive at $40,252,000. State and municipal bonds accounted for $23,355,000; corporate securities for $15,431,000; and PWA allotments for $1,466,000. During the month more triple-play bond sales—local bodies to PWA to RFC to the public—in the amount of $8,176,000 were consummated.

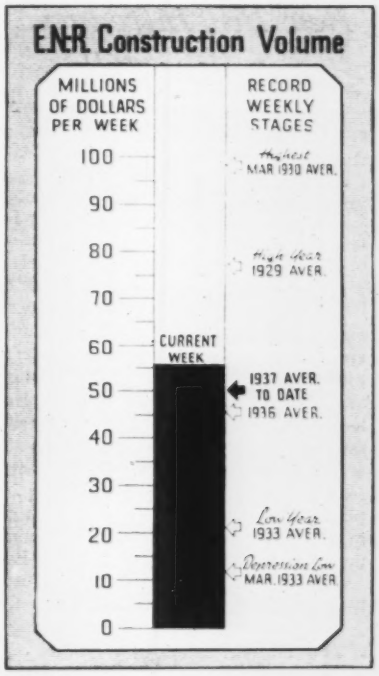
Half-Year Picture

June ended the half year. Contract awards during the 6 months were 15 per cent above 1936. Private awards were up 124 per cent and public awards down 23 per cent. Comparative 1936 and 1937 figures are: total, $1,121,375,000 against $1,245,428,000; private, $298,630,000 against $640,258,000; and public, $822,745,000 against $605,170,000. The detailed break down of the totals by classifications and by territories is given in the table at the bottom of the opposite page.

• • •

INDEX NUMBERS

ENR COST	1913 =100	1936 =100	ENR VOLUME	1913 =100	1926 =100
July, 1937	241.75	116.21	June, 1937	245	107
June, 1937	238.15	114.48	May, 1937	213	93
July, 1936	204.40	98.25	June, 1936	194	85
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50



THIS WEEK'S FIGURES

CONTRACTS

(Thousands of Dollars)

	Week Ending July 2 1936	June 24 1937	July 1 1937
Federal	$7,704	$4,761	$9,127
State&Municipal	25,260	40,854	23,579
Total public	$32,964	$45,615	$32,706
Total private	4,503	69,915	22,772
TOTALS	$37,467	$115,530	$55,478

1937 (26 weeks) $1,300,906
1936 (27 weeks) $1,158,842

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Week July 1	Cumulative
NON-FEDERAL WORK	$26,841	$624,914
State & mun. bonds	17,541	274,368
Corporate securities	9,300	278,292
PWA loans and grants	....	42,315
RFC loans	....	29,939
FEDERAL WORK	....	.....
TOTAL ALL WORK	$26,841	

1937 (26 weeks) $624,914
1936 (27 weeks) $462,018

Although only half of last week's record volume, contract awards this week, at $55,478,000, represent a 48 per cent gain over the corresponding week last year. They include $2,772,000 private; $23,579,000 state and municipal; and $9,127,000 federal.

The increase in the cost index for July is accounted for by higher common labor rates. The materials components are unchanged.

THIS WEEK'S LARGE CONTRACTS

Plant—American Viscose Corp., Front Royal, Va.			$1,000,000
Factory—Holly Sugar Corp., Hardin, Mont.			1,500,000
Power plant—Iowa Power and Light Co., Des Moines			1,500,000
Housing—Parkside Project, Detroit			3,395,000
Housing—Bakst project, Lackawanna, N. Y.			1,329,000
Towers—Bronx-Whitestone Bridge, New York, N. Y.			1,128,000
Sewers—Bualo Sewer Authority			913,000
Pipe line—Keystone Pipe Line Co., Williamsport, Pa., to Buffalo			1,750,000
Highways—Iowa $635,000	New York	$2,256,000	Illinois 585,000
	Ohio	689,000	Texas 956,000
	Wisconsin	1,013,000	Calif. 1,042,000

New Bill Introduced For Bonneville

Mansfield bill provides army control of plant with administrator to sell power

Chairman Mansfield of the House Rivers and Harbors committee has introduced a new bill for the disposition of Bonneville power which includes a provision referring the revision of Boulder Dam power rates to an unspecified federal agency for decision after study and public hearings. The bill is understood to be based upon a compromise among several pending measures that will be acceptable to the full committee.

Responsibility for the operation and maintenance of the entire Bonneville plant is placed with the Army Engineers, who are directed to install additional generating equipment as called for by a Columbia River Administrator to be appointed by the Secretary of the Interior.

The administrator will market the power and will be advised by a three-man committee representing the War Department, Interior Department and Federal Power Commission. He will build, buy or condemn distribution facilities and enter into power contracts extending not more than twenty years, with rate revisions at intervals of not more than five years. Preference will be given public distributing agencies, and contracts with private distributors will be cancellable on five years' notice if power concerned is needed by a public body. Contracts may specify resale rates.

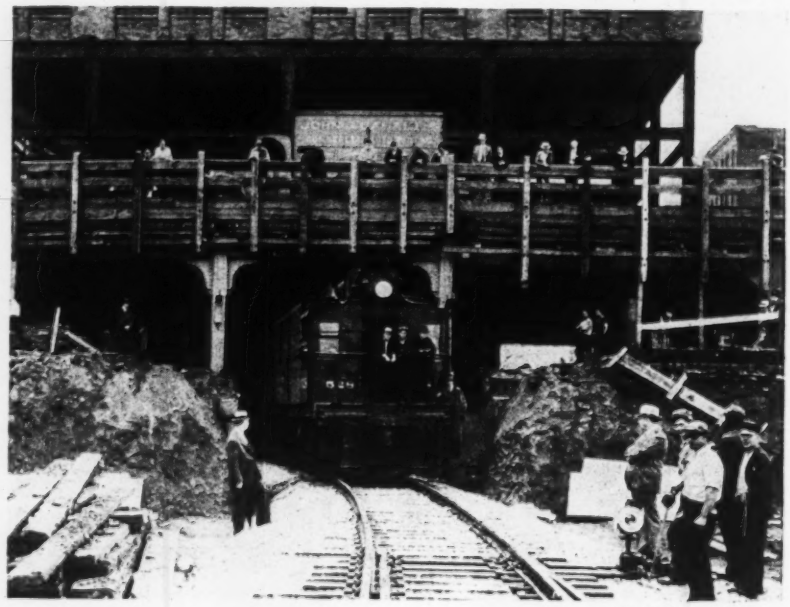
Wholesale rate schedules will be drawn up by the administrator, to be effective upon approval by the Federal Power Commission. New rate schedules will be prepared whenever the commission asks, and if the administrator fails to submit suitable schedules, the commission may determine the effective rate.

Rates shall consider (a) widest possible distribution, (b) cost of generation and distribution, including amortization and interest. Costs chargeable to power shall be determined by the Administrator subject to FPC approval. In determining the interest rate to be charged, the Commission shall apply the same rate to all major federal projects. This provision indicates strongly that the administration intends to have the commission regulate all such projects.

The Boulder clause directs a federal agency to be designated by the President to report before the end of the year, after public hearings, (a) whether the present Boulder contracts discriminate against that project with respect to charges against power for construction, amortization and interest, and (b) what changes should be made to correct such discriminations. It also directs the Secretary of the Interior, subject to the approval of the President, to adjust Boulder rates as he deems necessary.

It is specifically provided that no reduction shall be made in the payments to Arizona, Nevada or the upper basin states, except that the first two may, at their option, be permitted to accept $300,000 annual payments each until 1987 in lieu of the percentage of any surplus to which they are now entitled.

The President has indicated to Mr. Mansfield that the study will be made by the Federal Power Commission.



Wide World Photo

GETTING TRAINS OFF NEW YORK CITY STREETS

FIRST TRAIN passed over the new depressed freight line of the New York Central at New York City on June 27, marking the end of main line rail operations on 11th Avenue, over which freight traffic has moved for more than 80 years.

The New York Central freight line is through an open cut on private right-of-way between 10th and 11th Avenues, extending from 35th Street to 60th Street. The cut passes under 24 intersecting streets, and its construction required, pulling down of about 200 buildings. Diesel and electric locomotives will operate over three tracks for the present.

Below 30th Street, the freight line runs on an elevated structure completed in 1934.

Above 60th Street, the railroad passes through its own yards as far as 72nd Street and thereafter runs to the Harlem River through a cut covered over and landscaped beside the new Hudson River Drive.

• • •

San Francisco to Vote On Subway System

Action of the San Francisco Board of Supervisors, in instructing the city attorney to prepare legislation for a $49,250,000 subway bond issue for submission to the electorate, seems to insure that voters will pass upon the bond issue at the November 2 election.

The plan now under consideration calls for three subway units, one on Market and Mission Streets, one on Geary and Montgomery Streets, and one on Columbus Avenue.

• • •

Case Retires from Firm

Montgomery B. Case will retire from the firm of Modjeski, Masters & Case, consulting engineers, of Harrisburg, New York, and Philadelphia, on July 1, by mutual agreement. Ralph Modjeski and Frank M. Masters will carry on the work of the firm with no other change in the organization. Mr. Case has not announced his future plans. He entered the firm in 1933, following five years as engineer of construction of the Port of New York Authority, in charge of construction of the Kill van Kull arch and the George Washington bridge across the Hudson, and of the preliminary work for the Lincoln (Midtown) Tunnel. Previously he had been engineer of construction of the Philadelphia-Camden bridge, following years of work on bridges elsewhere.

Issues Are Clarified On Wage Bill

Hearings on Black-Connery bill focus controversy on a few main issues

As hearings closed on the Black-Connery bill last week, the unsettled state of Congress made it impossible to predict what the fate of the bill will be. After restudying the bill in the light of the testimony adduced the committee will consider a substitute bill introduced last week by Senator Bridges, New Hampshire Republican, which would provide a 40-hour basic week and 40-cent per hour basic pay with variables, written into the law, which employers would apply at their own discretion. No administrative board would be provided, and North-South differentials would be left to Congress.

Out of the volumes of testimony on the labor standards bill, four main issues emerged. The most opposed feature is Section 5, which gives the proposed Labor Standards Board power to supplement collective bargaining in industries or regions where it judges the facilities for bargaining inadequate. Much controversy has centered around the lack of regional wage differentials in the bill, particularly as between the North and the South, and there has been disagreement also on the lack of any specific protection for manufacturers against low cost imports and concerning the exemption from the provisions of the bill of the smaller employer.

Section 5 was strenuously opposed throughout the hearings by nearly all witnesses from both industry and labor, with the single exception of Sidney Hillman, president of the Amalgamated Clothing Workers. It is generally supposed that Congress, under pressure from industry, will eliminate this section, despite Senator Black, who says the act will be worthless without it.

Southern committeemen and witnesses have stood for a regional wage differential which could be applied by the board in favor of the South. The question whether low wages in the South are based on economic conditions or on a lower standard of living does not seem susceptible of proof, or at least of decision.

The proposal to exempt small employers from the act has been opposed by nearly every witness, and the committee appears to be against any exemption. The argument is that all small firms in existence and more that would spring up would take advantage of sweated labor to compete against larger firms.

There has been no opposition to the child labor provision. Senator Black contended that child labor legislation would stand a better chance if included in a labor standards bill along with other conditions which definitely affect interstate commerce, inasmuch as the courts have claimed that child labor did not.

No objections were made in the hearings to the strike-breaking and espionage provisions, except that several said these should be covered by the Wagner labor relation act instead.

• • •

Highway Shake-Up Started In Minnesota

A shake-up in the Minnesota Highway Department was begun last month with the discharge of two officers and the transfer of two others.

Ray Short, manager of the state-wide planning project, and C. M. Mathies, assistant manager of the project, have been discharged. The positions on the project will be filled by George F. Ludwigson and Henry Cass.

W. F. Rosenwald, chief maintenance engineer, has been transferred to duties in connection with public safety work, and his place will be filled by L. L. Allen, assistant maintenance engineer. D. H. Gilchrist, division engineer for the Detroit Lake-Morris District, becomes assistant maintenance engineer.

F. O. Nelson, district maintenance engineer at Marshall, has been transferred to a headquarters position of lesser responsibility at St. Paul, and C. M. Woodbeck will take over the position in Marshall.

• • •

Public Power Approved On All-American Canal

Two government contracts for the development and extension of a public power system for the Imperial irrigation district were approved by electors of the district at a special election June 16. A PWA grant of $1,242,000 and loan of $1,518,000 was accepted for the purpose of building a power plant on the All-American Canal, together with transmission and distribution lines, and to increase the capacity of the Brawley diesel standby plant, and an REA contract for $700,000 for the construction of 600 miles of rural power lines was also approved.

Approval of these contracts marked the rejection of a compromise which was proposed to the district directors by the Nevada-California Electric Corp. (*ENR*, June 3, 1937, p. 841).

After the election, the power company filed a suit in Washington, D. C., seeking to enjoin the PWA loan.

Activated Sludge Suit May Cost $5.000.000

Judge holds Milwaukee saved five million by infringing activated sludge patents

A saving of $4.977.000 was made by Milwaukee Sewerage Commission in adopting the activated sludge process of sewage treatment rather than the Imhoff-trickling filter type according to a memorandum of Judge F. A. Geiger, of the U. S. District Court, in the successful patent infringement case brought by Activated Sludge, Inc. against the commission, the City of Milwaukee and a group of contractors. On the basis of this memorandum of June 22 as to savings, following protracted hearings, Judge Geiger ordered the parties to prepare and submit findings. The effect of the conclusions of law or of the judgments is left for further consideration at the time of settling the findings.

Basis of Comparison

Although ten different systems of sewage disposal were originally considered by Milwaukee, only the estimate of costs of a comparable Imhoff-trickling filter plant was utilized in making costs comparisons. Essentially the judge accepted the figures produced by George B. Gascoigne, engineer expert for the company, and rejected those of the experts for Milwaukee, who were Black, Greeley and Ferebee.

Two other methods of computing damages were offered to the judge aside from the savings method adopted: (1) straight royalty fees and (2) a method based on amounts paid by other cities. In this connection Cleveland, was reported to have paid $150,000 and Indianapolis $75.000.

Said the judge "I have not considered, and do not make any finding or express an opinion, upon any other basis of recovery for the reason that the proofs submitted under the rule invoked by the plaintiff are found adequate and sufficiently certain."

The savings calculated by the plaintiffs' engineer were as follows:

Construction cost.....	1,826,935
Operating costs.....	775,390
Interest (10.4219 yrs. @ 4.563%)	868,801
Total on original plant....	3,471,126
Extensions to original plant	1,235,917
Contractors' profits.....	270,249
Total savings.....	4,977,292

Hugh L. Cooper Dies

Hugh L. Cooper, world renowned builder of hydro-electric power plants, died of arterio-sclerosis at his home in Stamford, Conn., on June 24 following three weeks' illness. Col. Cooper was in his 72nd year. He had recently returned from one of his frequent visits to Russia, the scene of his greatest engineering feat, the building of Dnieprostroy dam and power plant for the U.S.S.R.

Lacking scholastic training in engineering but endowed with remarkable natural engineering ability and boundless energy, Hugh Cooper has been a notable figure in engineering for nearly half a century. Since he built the first great power plant on the Mississippi at Keokuk, Iowa, he has been recognized as one of the world's foremost builders of dams and power stations.

Col. Cooper was a rare combination of engineering skill and executive ability. Outspoken and blunt almost to the point of gruffness, he was nevertheless the idol of those who worked under him because he was invariably fair and full of natural kindliness. But his blunt frankness got him into difficulty with many of those who were looked upon as leaders in professional matters in his early days because he was not the least impressed by their assumed air of great dignity and was quite frank in his criticism when their plans appeared to be dictated by tradition rather than common sense. In later years, when he had built up a reputation for himself, he got into like disfavor with some of his brother engineers because he insisted on putting a higher value on professional services than many of the more conservative thought it politic to endeavor to collect. This disfavor on the part of the ultraconservatives among engineers caused Col. Cooper no end of amusement.

A bridge builder

Few now recall that Hugh Cooper first made a name for himself as a designer and builder of bridges. Born in Sheldon, Minn., and educated in the Rushford High School, after a few months of railroad work he went into bridge construction in 1884, where, under the direction of Horace E. Horton, he learned how to design bridges. From 1889 to 1890 he dropped bridge building to take charge of new shops for the Chicago Bridge & Iron Co., by whom he was then employed; later he went into the field as a general foreman for that company. In 1891 he went to Spokane as northwestern manager of the San Francisco Bridge Co., where for three years he designed and built bridges, including a 500-ft. steel arch for the Spokane Falls & Northern R. R.

But young Cooper believed that a greater future lay in water power development, and so in 1894 he began bidding on small water power projects in Washington, subsequently becoming associated with John T. Fanning in water power studies and construction work. In 1897 he became assistant chief engineer of the firm of Stilwell-Bierce & Smith-Vaile Co., builders of water wheels, a position that he sought in order to learn the fundamentals of turbine design.

Cooper's first big hydro-electric project was a 20,000 hp. plant in the mountains of Brazil for the Sao Paulo Tramway, Light & Power Co., a job that was complicated by the high altitude in which it had to be carried forward. From there Cooper went to the Mexican Light & Power Co. of Montreal as chief engineer, and then to the Electrical Development Co. of Ontario as chief hydraulic engineer. In the latter position he put forward a proposal for discharging water from the company's projected power plant through a tunnel opening behind the falls. This and other proposals in connection with the plant were such radical departures from accepted practice that the British capitalists called in British engineers to pass on the whole project. The latter hesitated to endorse it. Sensing the situation, Cooper hurried to New York to J. James R. Croes, then one of the country's outstanding engineers, convinced him of the soundness of his proposal and engaged him to go to Toronto, where he gave full endorsement to Cooper's proposal and won its adoption.

HUGH L. COOPER

Returning to this country after several years of active work in Canada, Cooper took charge of construction of the power plant at McCall's Ferry in the Susquehanna River from 1905 to 1908. It was in that work that he originated the plan, now widely used, of building the dam with traveling cranes from trestles along the line of the dam.

Mississippi power

Subsequently Cooper became interested in a proposal to build a power plant on the Mississippi River at Keokuk, Iowa, a project that was in difficulties due to skepticism concerning the economic possibilities of a low-head plant, especially as it was located in a region having relatively cheap coal. Convinced that the project had economic possibilities if properly handled, Cooper was able in 1910 to get financial backing for it, but to keep down the cash requirements agreed to take the major part of his compensation in stock of the company. His faith in the project was well founded and brought both to Cooper and the backers large returns financially and in addition brought Cooper still wider recognition as an engineer.

Builder of Muscle Shoals

With this experience as a background, it was natural that the War Department, when it came to build the great dam and power plant at Muscle Shoals, should recall Col. Cooper from France, where he was serving as chief engineer on the port project at Bordeaux. His work at Muscle Shoals is well known, but it is worth note in passing that it was there he became convinced that concrete so wet that men could not walk on it without sinking over their shoe tops was too wet to produce good results. From that time he became one of the active proponents of dry mixed concrete as we know it today, as compared with the poured concrete of the early part of the century.

Dnieprostroy

The years following completion of the dam at Muscle Shoals were active ones for Col. Cooper, but much of his work was on studies that have not come to fruition. All of it now is overshadowed by the building of the Dnieprostroy Dam and power station in Russia, which in many respects was the climax of his career. Worthy of special note in the post-war period are his studies of the Z-Canyon project at the headwaters of the Columbia, his exhaustive studies of power development in the international section of the St. Lawrence River for the Aluminum

Wide World photos

RECLAIMING NEW YORK'S RIVER FRONT

AWARD of a contract to the Frederick Snare Co., for filling in a park area and constructing a bulkhead and sewers brings near to completion a section of New York's East River drive from Grand St. to 14th St.

The above view, looking north from the Williamsburg Bridge, shows the divided-lane construction of the drive, which will include a raised center strip varying from 6 to 10 ft. in width.

This section is part of an ambitious plan to circle the island of Manhattan with landscaped high-speed drives. Construction of this first section of the East River drive will be followed by a second section from 14th St. to 32nd St. Later the drive will be extended from that point to 49th St. on an elevated structure, then north for five blocks on the surface, and then for six blocks through tunnel under Sutton Place. It will then continue along York Avenue to join the approaches to the Triborough Bridge and connect with the Harlem driveway.

On the south it is planned eventually to extend the drive to the Battery.

Company, Du Ponts and the General Electric, and his participation in the remarkable design for raising Aswan Dam in Egypt.

Hawk's Nest penstock

Within recent months he took an active part in the studies of the penstock failure at the Hawk's Nest hydro plant in West Virginia and in the reinforcements of the penstock. His last engineering trip was to the Hawk's Nest plant to witness a severe test on the strengthened penstock that he insisted should be made.

Col. Cooper's knowledge of engineering was not superficial, as many who knew him only by reputation believed. He knew the fundamentals of structural design and of hydraulics thoroughly and liked nothing better than to match wits with the specialist. His design of a draft tube for one of the station units at Muscle Shoals that showed higher efficiency than the one designed by one of the turbine makers is an example. His greatness as an engineer lay in two faculties, the power to go to the root of a problem without being distracted by trivialities, and his ability to handle and win the confidence of men.

St. Louis Smoke Law Claimed Void

Two coal operators have sought an injunction from the Federal Court against enforcement of the St. Louis smoke abatement ordinance. The petitioners claim that the act is unconstitutional because the classification of certain types of coal is unreasonable, because the title is defective, and because the bill attempts to regulate interstate commerce. The city asserts that the bill comes properly within the police power of the city, and does not attempt to regulate interstate commerce inasmuch as the ordinance, which prohibits transportation of certain types of coal into St. Louis, applies only when the coal is offered for sale within the city.

The coal operators contend that the provision of the ordinance requiring washing of certain types of coal and hand-picking of other types is unreasonable inasmuch as the cost is prohibitive and the processes do not in themselves tend to reduce smoke. Both these contentions were denied by the city's representatives.

Action Seems Likely On Housing Bill

Washington Correspondence

Early action on the proposed Wagner Housing bill appears likely from the statement by the New York Senator after a conference with President Roosevelt, that he and the President had "practically reached an agreement" and that he proposed to prepare an amendment to his bill, which would provide an alternative "or optional" method of providing government aid. This optional method, he intimated, would be available to any community which might prefer it to the other method in the measure. The Senator declined to give any intimation of what the method might be.

The delay in action on the Housing measure has arisen largely over the dispute regarding the proposed subsidy plan, by which the Government would be obligated to pay subsidies for 60 years. The President has objected to that idea on the ground that he feels the current administration has not the right to commit the Government for that length of time.

The Wagner bill provides an appropriation of $50,000,000 for the first four years of the low-cost housing plan and a bond issue of $1,000,000,000 to be loaned on projects.

The only alternative plan so far suggested for the subsidy plan is that of the capital grant, by which the government would make an allotment and then cease financial aid.

. . .

Whitestone Bridge Tower Contract Awarded

The American Bridge Co. of Pittsburgh has been awarded a contract for construction of the towers on the Bronx-Whitestone bridge, the Triborough Bridge Authority has announced. American Bridge's bid was $1,128,000.

The Whitestone bridge will be a suspension bridge across the East River, five miles upstream from the present Triborough bridge. The main bridge will consist of a single span of 2,300 ft. and side spans of 735 ft.

Plans for acquiring property for approaches to the Whitestone spans were launched June 18, when the New York Board of Estimate voted to buy land in the Bronx and in Queens with an assessed valuation of $1,596,000.

The bridge authority awarded the contract for construction of the tower piers and foundations for anchorages and approaches for the bridge to the Frederick Snare Corp. of New York City. (*ENR*, June 24, 1935, p. 927).

Company-TVA Pact Agreed On

TVA agrees to sell power from Pickwick Dam to Arkansas Power and Light Company

A contract has been agreed on between the Arkansas Power & Light Company, and the Tennessee Valley Authority covering the sale of surplus power produced by the authority at Pickwick Landing Dam. Contract will be formerly executed only after the power company has submitted it for approval of the Federal Power Commission and the Arkansas Public Utility Commission.

The contract is for a period of five years, after which it renews itself automatically from year to year, unless terminated by either party on 2½ years notice. It is estimated that the gradually increasing sales and payments will, in the fifth year, bring an annual revenue to TVA of about $750,000.

Power will be delivered to the company at a sub-station near Memphis on the 154,000 volt line now being built by the authority between Pickwick Landing Dam and Memphis. Power sold to the company is for distribution in the State of Arkansas over the company's own lines.

Company and TVA agree to furnish each other with stand-by service in cases of emergency, resulting in considerable saving in investment for additional plant and equipment by both parties.

The contract provides for sale of firm, interruptable, and run-of-stream secondary power, starting at the first year with the sale of 10,000 kw. of interruptable power (guaranteed for 300 days of the authorities' selection in each year), and reaching a basis after five years of the sale of 35,000 kw. of firm power and 5,000 kw. of run-of stream secondary power.

The power will be sold at the regular TVA wholesale rates at which power is regularly sold to municipalities and co-operatives.

Commenting on the power contracts, Representative Rankin of Mississippi, co-author of the TVA Act said: "If such a contract is made, I hope it will be of the shortest possible period of duration, and by all means it should contain a provision, written into the contract, requiring Arkansas Power and Light to resell this power to the ultimate consumers at TVA yardstick rates."

He added that unless retail rates are controlled in the contract, it will be the last contract written between TVA and a private utility.

Moffat Tunnel Builder Dies

Frederick C. Hitchcock, engineer and contractor, who built the Moffat Tunnel in Colorado, died June 28 in New York City, at the age of 73. Mr. Hitchcock was the head of Hitchcock & Tinkler, New York contractors, organized in 1923 for the purpose of constructing the Moffat Tunnel. Mr. Hitchcock also supervised the construction of many engineering projects in the United States and abroad. One was the 10 miles of tunnels at Ashokan Dam, a principal source of New York City's water supply.

Following his engineering training at the University of Michigan, Mr. Hitchcock was engaged in railroad construction. In 1907 MacArthur Bros. of New York and Chicago engaged him as vice-president and general manager. In the nine years he spent with this company he supervised construction work on the Ashokan Dam tunnel and on various railroads, power dams, docks and subways. Later, with MacArthur, Perks & Co., he directed the construction of extensive docks at Havana. During the World War he supervised construction of cantonments and shipyards, and in 1923 his own firm was organized. Since 1927 he had done considerable work in an advisory capacity on foreign construction projects including work in Greece and Turkestan.

• • •

Cincinnati Crossing Jobs Held Legal by Court

The Common Pleas Court, in Cincinati, in a decision handed down June 22, held that the City of Cincinnati might legally accept a grant from the state and the federal government for the elimination of railroad grade crossings of highways.

A taxpayer suit had sought an injunction against the project on the ground that the Federal Relief Act of 1935 and the Ohio Emergency Relief Act were unconstitutional, in that expenditure of funds from the grant is subject to restriction as to wages and hours, and requires that preference in employment be given to persons on the relief rolls. The suit held that this constituted an unlawful delegation to the president of the powers of the city and state.

In his decision, Judge Gorman held that it was within the power of the state and federal government to provide for the relief of unemployment, that the projects attacked were part of a general unemployment relief program, and that acceptance, by the city, of a gift subject to conditions did not in itself constitute a delegation of authority.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

HOUSE committee on flood control on June 28 reported favorably a bill authorizing new projects in the Ohio Valley totalling $24,877,000. The bill was so phrased as to permit the selection by Major General Edward M. Markham, Chief of Engineers, of the projects from the levee, flood wall and drainage structures proposed in his recent report outlining a comprehensive flood control plan for the Ohio basin. It also authorizes the expenditure of $300,000 for channel clearing operations, and preliminary surveys under the direction of the Department of Agriculture covering soil erosion control and the retarding of flood water in upland regions of the Valley.

The purpose of the bill is to add badly-needed projects in the Ohio Valley to the list of authorized projects from which the Chief Engineers will select those to be placed under construction with funds provided in the pending War Department bill.

The Senate on June 22 confirmed the nomination of John W. Scott to be a member of the Federal Power Commission. He succeeds Herbert J. Drane.

An additional allotment of $1,600,000 has been made by the Public Works Administration to the Corps of Engineers for use in the Muskingum Valley flood control project in Ohio, on which work is now approaching completion. The grant, made from the old NIRA fund of 1933, brings the total federal participation in the project to approximately $25,500,000. Although the purpose for which the new allotment was made has not been specified, it is understood that the fund will be available to reduce the burden of local participation in costs. The bonding power of the Conservancy District, is limited to $6,000,000. An additional $2,000,000 has been contributed by the state of Ohio, which has also assumed the cost of highway relocation.

News continued on page 38

ENGINEERING NEWS-RECORD is a consolidation of Engineering News and Engineering Record, effected in 1917. The Contractor was consolidated with Engineering News Record in 1918. Engineering News was founded in 1874 as The Engineer and Surveyor, which title subsequently became The Engineer, Architect and Surveyor, Engineering News and American Railway Journal and finally Engineering News. Engineering Record was established in 1877 as The Plumber and Sanitary Engineer. The name was subsequently changed to The Sanitary Engineer, Engineering and Building Record, and, finally, to Engineering Record. All rights to the above titles are reserved.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Cascade Tunnel

Sir: I note from your issue of June 10 that the advocates of the 35-mi. Cascade Tunnel have invoked the prestige of a great engineer to give an appearance of plausibility to their interesting scheme. I doubt, however, if even Joseph B. Strauss can "shorten the distance between these two towns (Leavenworth and Skykomish) by seventy miles," since they are now only 47 mi. apart by highway and 49 mi. apart by the main line of the Great Northern Railroad.

If he can accomplish this feat, however, he should then be able to demonstrate the economic feasibility of the tunnel, a minor detail that so far has not been thought worthy of anybody's attention. Possibly such great public works as this are in these days free from such sordid considerations.

Pullman, Wash.
June 18, 1937

H. E. PHELPS,
Professor of Highway Engineering
State College of Washington

Our statement was inaccurate due to shortening the news item to fit space limitations. The project includes straightening the highway between Seattle and Skykomish, which, with the new tunnel, will effect a total saving of 70 mi. between Seattle and eastern Washington. — EDITOR

To Promote Construction

Sir: An organization known as the Joint Conference Board, which has been functioning in San Francisco for about two years, has the objective of (1) improving the service to the community rendered by the construction industry and (2) discussing problems in which there is a community of interest among various branches of the construction field generally. The organization is the outgrowth of a suggestion from the northern California chapter of the Associated General Contractors; it has expanded as results have brought encouragement and now is a representative body.

The board consists of appointed representatives (and alternates) from organizations in or affiliated with the construction industry, including architects, engineers, general contractors, the producers council, chambers of commerce, etc. Informal noon meetings are held with discussions on previously announced subjects. Resolutions, drawn up along broad lines, are submitted to component organizations. Special committees are appointed for particularly important studies. There are no standing committees; officers consist only of chairman and secretary, and expenses of operation are less than $10 per year per organization represented. Activity along parallel lines on a national scale has been suggested recently. Details may be had from the secretary, Joint Conference Board, 205 Sharon Building, San Francisco.

San Francisco, Calif.
June 15, 1937

A. V. SAPH, JR.

Approved As More Readable

Many readers of Engineering News-Record have written us concerning the new typography initiated with our June 10 issue. Their comment indicates that the paper is distinctly more readable, and thus that the change is at least in part successful.

A few of the comments selected at random follow:

Hearty congratulations upon the new form of Engineering News-Record. I always enjoyed the old form and thought it a very excellent publication, but it does seem that you found ways of improving it.

— BLAKE R. VAN LEER

I want to compliment you on the "new" old Engineering News-Record. It is very attractive to the eye. I feel you have made a step in the proper direction.

— DENIS F. O'BRIEN

The new cover styles the paper up to date, and I doubt if you can make much improvement in the quality of the editorial matter, which has always been first class.

— GEO. H. GIBSON

Congratulations on the new ENR. I like the new cover design, the rearrangement of the body, and the new style headings. I am not so sure the body type is more readable.

— W. H. SPINDLER

I wish to congratulate the editorial staff on the revision of format in which Engineering News-Record now appears.

— HENRY W. TAYLOR

The new Engineering News-Record is more interesting than the issue which preceded it. I want to add my word of congratulation on the change.

— C. C. CONNER

For 35 years I have been a reader of Engineering News-Record and its predecessors, and I wish to compliment you on the new dress and interesting makeup of this new friend.

— A. R. ELLIS

The cover is an unusually happy combination of dignity, authority and lively interest.

— R. F. WOOD

I like the new format and spirit of Engineering News-Record.

— E. J. MEHREN

A subscriber of long standing thanks you for protecting his investment by the modernization of Engineering News-Record.

— C. A. BETTS

The new type is much easier to read. The general appearance is greatly improved; it is more attractive and readable.

— LEE WARREN

An improvement in arrangement and makeup.

— C. B. SMYTHE

You have done a good job in your improvement of structure and typography, and have accomplished the objectives set out. Best wishes for your continued success in ever larger service.

— V. B. SCOTT

May I express my compliments on the new arrangement of the interior, and the new type? I like everything about it except the front cover. As Joe Cook says: "Fannie Brice went on a diet. Result—same old Brice but a new Fannie."

— E. L. MCFALLS

ENGINEERING NEWS-RECORD

Copyright 1937, by McGraw-Hill Publishing Company, Inc.

Volume 119, Number 1

Editor, F. E. SCHMITT · *Editorial Staff*, V. T. BOUGHTON
N. A. BOWERS, W. G. BOWMAN, W. W. DE BERARD
C. S. HILL, H. W. RICHARDSON, E. J. CLEARY

Editorial Offices at 330 West 42nd Street, New York

JULY 1, 1937

REMARKABLE WORK WAS DONE in saving the Grand Coulee cofferdam. A few supplementary words deserve to be added to the account of the job. It was fortunate that the Columbia's threat to the cofferdam came at low river stage, for this made it possible to carry the fight through before the arrival of summer floods. Even so, however, the time available was alarmingly short, and praise is due the clever strategy and resourceful use of equipment and materials that controlled the inflow just in time. A big construction job normally follows prescribed routine, applying predetermined methods according to a rigid program schedule, but all this is changed when an emergency comes, most of all when a cofferdam break is imminent: No longer is there standard procedure or fixed schedule; all is subordinated to discovering causes and applying remedial measures. The highest skill of the construction engineer is called into action by such incidents. Grand Coulee has seen many emergencies, and up to now all have been met successfully. The contractors are one up on the swift-flowing Columbia; their latest success gives assurance that they will maintain their record through to completion.

Hugh Cooper's Legacy

CIVIL ENGINEERING lost a picturesque figure in the passing of Hugh L. Cooper. Forceful in every look and action, striking in appearance, and blunt-spoken to a degree that startled those who did not know his deep natural kindliness, he was a person to impress all with whom he came in contact. But the profession has lost through the death of Col. Cooper something far more significant than an impressive figure: it has lost another of those rare men to whom engineering judgment is almost instinctive, men who without formal engineering training have risen to preeminent position in the world by sheer force of native ability and hard work. The inspiration and counsel of these men is an asset that the world can ill afford to lose by closing the door through which they entered the profession. They became eminent engineers without spending a day in an engineering school; today the profession is rapidly moving toward the time when a man cannot become an engineer without college training. If Col. Cooper's example causes the profession to recognize that it should not lean too heavily on scholastic training, he will have left a legacy of inestimable value.

From the Past

EARLY SETTLERS in semi-desert wastes of the Southwest solved their water-supply problems by unique but practical means, means that survive as the best for water conservation in that region. The unknown pioneer who devised the scheme of damming a narrow canyon so that it would fill with gravel and stone whose voids would store water without loss by evaporation was an engineer of genius and resourcefulness. As described in this issue these underground "desert water tanks" have been used for about 150 years in southern Arizona and Mexico. But they are of more than historic or purely local interest. In a sense they symbolize an ideal of engineering achievement, namely, the application of scientific principles to practical and useful purposes. The thinking which inspired the "desert water tank" also created the more spectacular engineering structures that cover the entire world.

It Made History

FIRST EXPRESS HIGHWAY to be conceived and built, the Long Island Motor Parkway has reached its end and is offered to the public authorities. While it probably never paid (it was a private venture for profit) it occupies an important place in the records of highway development as marking the birth of an idea that seems destined to dominate much of the highway planning of the future. The initial conception may have been due to road races of early automobile days, which emphasized sensationally the fact that travel speed and safety require an unbroken roadway, easy curves and uniform surfacing. Whatever its origin, it made a fundamental innovation. A decade passed before the first parkways appeared, and two decades more before the rise of express highway planning began. If only for its historic importance, therefore, the Motor Parkway should be saved—modernized for continuing efficient service, perhaps, but saved in the main as a historic relic.

A New Order Prevails

THE PAVING TECHNICIAN of today faces the problem of refining his materials rather than of choosing between types. His task is especially precise in the case of materials that must be proportioned and compounded at the time of placing them on the street. Whether the binding material is cement or bitumen, the mix determines the success of the pavement; for one thing it must be uniform, and

this demands exact control at every step. As an example of the control exercised in modern bituminous paving the plant and procedure described on a following page deserve careful attention. Old in experience with asphalt paving, Detroit street engineers supplement personal craftsmanship by all that science can provide in devices for thermal and mechanical control. The essential lesson is that individual judgment no longer decides by sight and touch the fitness of bituminous mixtures: the mixtures are designed by laboratory research and are produced with all the exactness that practical mechanization can provide.

Uncle Sam Steps In

ABNORMAL FLOOD HAZARDS complicated by financial, administrative and political difficulties are at the bottom of the unprecedented decision of the national government to take over construction of Los Angeles County's local flood program, under the plan outlined on another page. It has been said, and with truth, that the fertile plain on which stand the populous cities of Los Angeles and Pasadena is under a more dangerous flood menace than any similar region in the United States.

For nearly a quarter century current literature of engineering has told of the Los Angeles County flood work; many pages of Engineering News-Record have been devoted to it. Shallow stream channels, dry most of the time, extend from a precipitous mountain range southward over a steeply sloping alluvial debris plain; under such conditions the flood possibilities of the torrential downpours that now and then occur in the mountains are self-evident. A vivid picture was given the world by the New Year's Day flood of 1934, when flood-transported debris overwhelmed the suburb of La Crescenta, built on one of the old debris cones.

The magnitude of the problem is characterized by the fact that the County has spent more than sixty millions in building parts of the required protective works, and that the initial plan calls for seventy millions more. But even these figures hardly do justice to the difficulty and diversity of the detailed engineering problems contained in the situation. Superadded to the need for curbing the flood waters and debris there is the necessity of saving as much as possible of the discharging flood waters to supply the ground storage, heavily depleted in recent years, on which the life of much the region depends.

Controversy has marked the work throughout its twenty-odd years of progress, even prior to the days when the Reagan plan for a dam of record-breaking dimensions in San Gabriel canyon set the engineering world by the ears. Much of the trouble may be traced to the inefficiency of the administrative setup prescribed by the state law, which instead of placing the undertaking in the hands of an independent and competent organization assigned it to the County supervisors as a spare-time job. These are the conditions that led up to federal intervention in the case two years ago, when the WPA took up a sixteen-million-dollar section of the project as a relief-work assignment. But soon afterward Congress decided that all the remaining work also should be done at national cost.

Other federal flood-control projects affect entire sections of a state or several states. Los Angeles County's case is the first and only one in which floods of purely local origin and influence have been made a national charge. Whether it will serve as precedent for a federal policy of taking over all flood problems, however narrowly limited to one locality, remains to be seen. If it does, the process of federalization of the civil engineer's work will have gone ahead by a large step, and the responsibility and autonomy of local communities will have been further lessened. It is this prospect that looms up out of the present case as the most significant accompaniment of its technical problems.

One Property or Many?

PAGES HAVE BEEN WRITTEN on workability of mortars and concretes, and many more will be written as the years pass. While some progress has been made in better understanding of its meaning, essentially the concept of workability—or of consistency—remains vague, and this is why there is so much discussion about the effect of fineness, of water, of aggregates, and of mixtures. Several independent physical properties seem to be grouped under the one name.

Listening to almost any discussion of workability one is apt to find that the behavior and conditions in the mind of B are not at all the same as those of which A had spoken; the first may be thinking of softness, the other of the ability to resist segregation, or of adhesiveness, or of the readiness of the material to take fine molding. Again, different methods of measuring workability or consistency differ in their results, and the measures used for concrete do not define the quality that the mason wants in his work.

Present confusion in workability suggests that we may know more about workability when the term is broken up into its components. At bottom this means more intensive study of test methods. For years the slump-cone test has been supreme; but while it brought a remarkable advance in the concrete art it limited the development of thought on workability. When each of the different kinds of behavior of concrete and mortar is duly represented by its own test, tangible progress in respect to workability will be in sight.

PICTURES IN THE NEWS

PAVING WORK has begun on Merritt Parkway in Connecticut and it is hoped to have the first 10 mi. of this 35-mi., $15,000,000 highway opened by fall. This 60-ft. rigid frame bridge carrying Stanwich Road over the parkway near Greenwich is typical of 50 to be built by the Connecticut State Highway Department.

CLOSURE of the center section of Fort Peck Dam and diversion of the Missouri River through the four tunnels occurred last week. This recent air view shows the stage set for the closure, made by dumping rock and gravel from the bridge at right center; the diversion tunnels are under the far bluffs. Pacific Aerial Survey-Wide World Photo

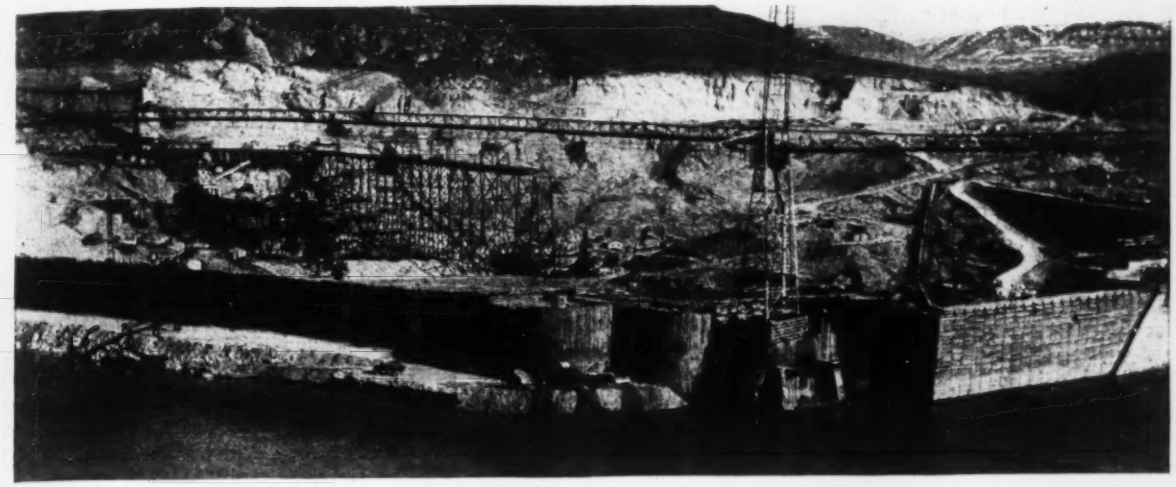


FIG. 1. TRUCKS PLACED A FILL OUTSIDE WHILE OTHER OPERATIONS WENT ON WITHIN THE COFFERDAM.

Contractors Win River Battle

Inflow under Grand Coulee Cofferdam of 35,000 g.p.m. threatened a serious loss but a resourceful fight, an effective grout "prescription" and reconstruction of cells made structure safer than before

COMPLETE STOPPAGE of the inflow under the cofferdam at Grand Coulee Dam was effected finally after a severe struggle carried on in the face of serious risk of flooding the east half of the foundation where concrete pouring now is under way. Reconstruction of cells in both up-and down-stream cofferdam arms was necessary and since this has been accomplished safely, it is believed that no flood likely to occur this summer will menace the unwatered area. An earlier report on repair operations was published in *ENR* April 22, 1937, p. 595; in the following are given additional data relative to conditions encountered and remedial measures adopted.

Fortunately, the river flow at the time the leak developed (March 16 to 20, 1937) was only about 27,000 sec.-ft. This made it possible to combat the inflow and to repair the cofferdam cells in a way to give greatly increased stability to the structure; these repairs would have been impossible had the weakness developed in flood season. However, even at low river flow, for a time there was grave danger of flooding the east cofferdam. This would have meant loss of a whole season, later pumping out a deep 50-acre lake, and another cleanup of the foundation rock; a catastrophe that might well have cost the contractor an enormous sum.

In combating the inflow, a crisis was reached on March 19 when a vortex developed on the river side of the downstream cell cluster. For a time the inflow into the cofferdam was 35,000 g.p.m., a rate four or five times that previously obtaining and sufficient to fill the remaining capacity in the protective storage hastily provided within the cofferdam in only one hour. In addition to the menace of the in-rushing water, failure of the cofferdam cells was imminent. Steel sheet piling in cells of the downstream cluster were badly distorted, some cells settled out of plumb and internal pressure became so great that here and there a vertical riveted seam was ripped open like a zipper. As rivet heads popped off in a row of 1-in. rivets on 3-in. spacing, two cells, one in the upstream and one in the downstream cluster burst, spilling their contents into the cofferdam. However, by the time the disrupting process reached a crisis, remedial measures had been well advanced and the inflow was controlled just in time to prevent flooding the cofferdam.

Remedial measures did not cease with stoppage of the inflow but continued in a program of rebuilding and strengthening the original protection works, particularly by driving more sheet piling to replace damaged cells. With new sheet piling down to bedrock at points where it previously ended some 15 or 20 ft. above, and with grouting and cell work completed, the cofferdam now is much stronger than before and is expected to withstand safely a river elevation of 990 (upstream side of cofferdam) which is the equivalent of a 500,000 sec.-ft. stream flow. A head differential of about 10 ft. obtains between upstream and downstream sides of the cofferdam. As much of the floor of the cofferdam is below El. 865, the flood mentioned would bring water surface 125 ft. above most of the coffered area (low-

est concrete was poured at El. 750). The capacity of pumps available for keeping the cofferdam unwatered totals about 60,000 g.p.m.

How the leak developed

The presence and location of the sand seam through which the inflow started was well known as the result of excavating through it in the west cofferdam. It was located at El. 896, varied from 4 to 10 in. thick, and was exposed all the way across the west cofferdam in the vicinity of block 40. In a sample of the sand analyzed, about half of the material would not pass a 48 screen. Infiltration through this stratum into the west cofferdam did not occur even though the path that inflowing water would have followed was shorter than the route into the east cofferdam through which the troublesome inflow later occurred.

However, in the east cofferdam there was present a new factor more significant than the length of the percolation path. This was the berm or fill that helped to hold the seam in place. Before excavation in the east cofferdam began, the much higher hydraulic heads had been resisted safely with the aid of back pressure on the seam. When this back pressure was relieved by excavation of the east cofferdam, even the low head at the time of the inflow was sufficient to bring in a large quantity of water.

Another factor was the distorted condition of the bottom of the sheet piling in the circular cells. The compact nature of the till through which these piles were driven was such that an attempt to drive more than 15 or 20 ft. was almost sure to cause the steel to split or to jump out of its interlock and there was no way to be certain that such deformity had or had not occurred. Bedrock under the cells that failed (*ENR* April 22, 1937, p. 597) is at El. 875 to 880, and the bottom of the original sheet piling was about El. 900. It is believed that the seepage first followed down the sheet piling, perhaps where a section had been split in driving, and after a through route had been developed, the passage was enlarged by the current. Support for this theory was found in the vortex on the outer side of the cofferdam at the time of maximum inflow.

Method of attack

When the inflow developed to serious quantities and a "run" was feared, the first move was to throw up a dike, or earth fill, inside the cofferdam, parallel to the direction of river-flow and about 250 ft. back from the river side. This provided a small lake, or sump which served to retain inflowing water and thus to keep it from flooding the remainder of the cofferdam. An emergency dumping program then was begun on the river side. With this under way a five-stage program for combating the leakage was begun; (1) first a substantial toe, or tight cutoff to bedrock inside the cofferdam and

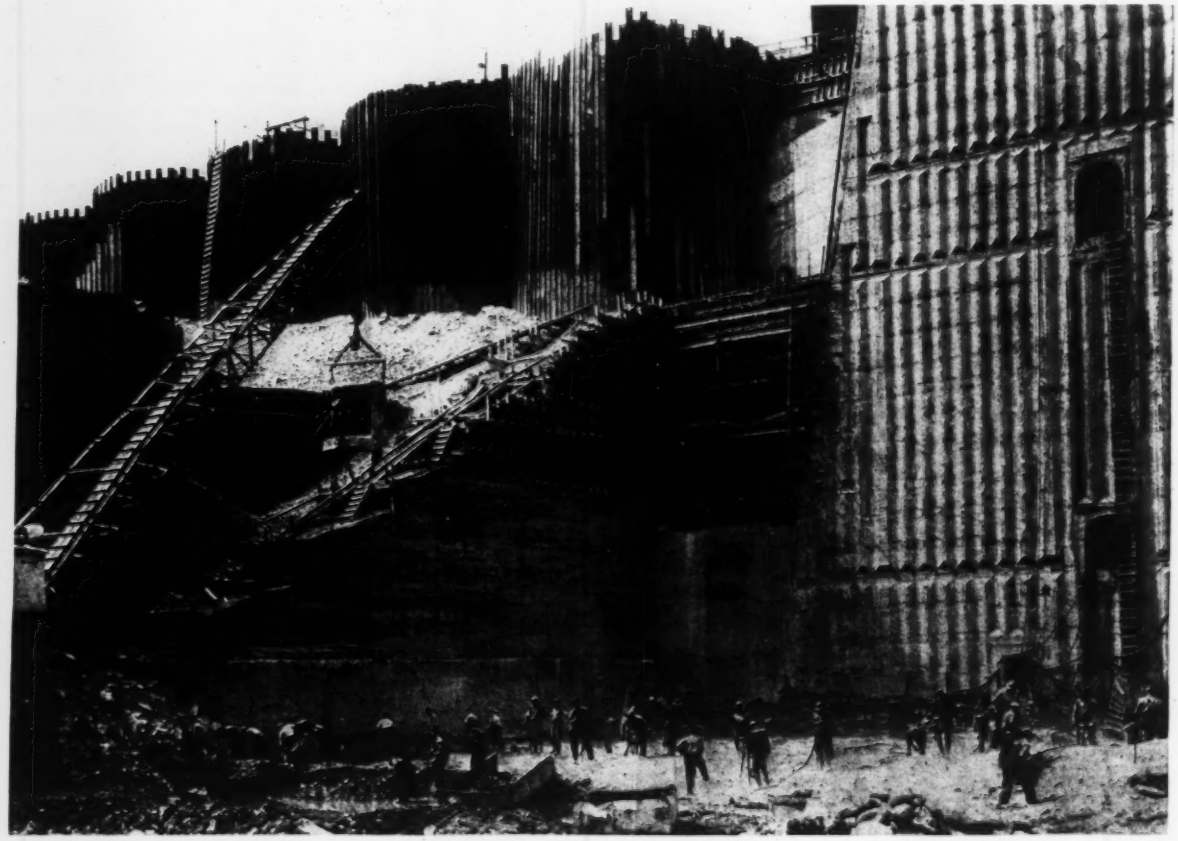


Fig. 2. The concrete buttress wall in left foreground, built in a week, strengthened this upstream cell cluster in the emergency. East face of block 40 at right. Workmen are giving granite bedrock a final cleanup.

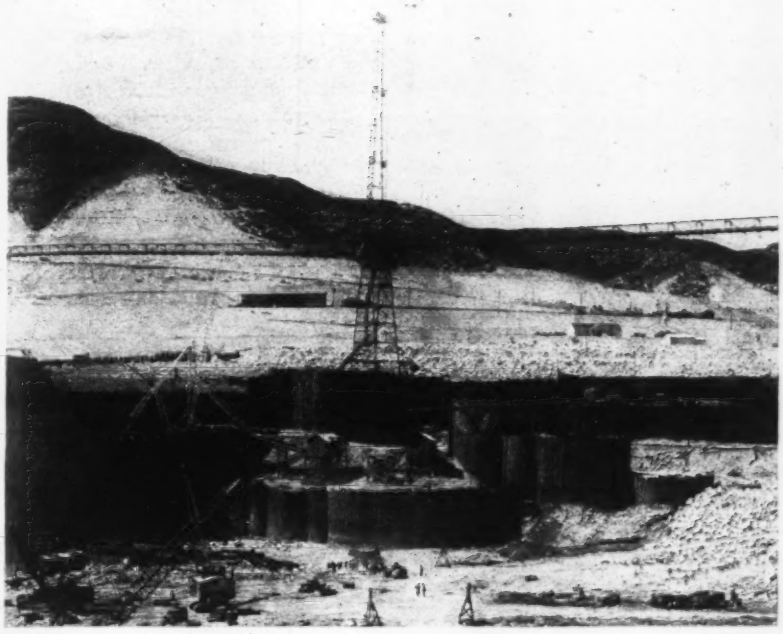


Fig. 3. The reconstructed downstream cell cluster. Note short arcs of sheet piling between cells in lowest tier.

near the leak was constructed; (2) between this toe and the undermined cells, a filter-bed was built up; (3) several means were employed, both outside and inside the cofferdam cells to plug this filter; (4) the ground lost was made good by emptying the cells to relieve the internal pressure and rebuilding or replacing them where necessary, and finally, (5) there was a restoration of the water face and incidental work such as underpinning of the conveyor-belt tower in its supporting cell.

The attempt to check the inflow by dumping material into the river along the outside of the cells was carried on from barges in the river which put down straw, brush, and facines weighted with rock, and by a fleet of the dump trucks making their own roadway as they advanced a fill along the outer face of the cells, beginning at the shore end of the downstream arm. At the critical point in this filling process three kinds of material were used in the hope of making the fill watertight by using graded materials in certain proportions. The ratio was as follows: clay, 34,000 cu. yd.; gravel, 28,000 cu. yd., and rock 10,000 cu. yd. It was recognized that there would be a limit to the effectiveness of this fill, regardless of the amount placed, because of a blanket of rip-rap that had been placed previously all along the outside toe of the cofferdam to prevent scour. Through this riprap the river had access to the previous seam from several angles.

Work inside the cofferdam

Despite expert opinion that "no one ever stopped a cofferdam leak from the inside", as soon as a reasonable amount of filling had been done on the outside, efforts were concentrated on those phases in the program of attack that were to be carried on within the cofferdam. These began with (1) a toe wall inside the cofferdam consisting of the circular cells of steel sheet piling described as R 1 to R 7 in the preceding article (*ENR* April 22, 1937, p. 595.) These cells were driven with the peripheries a few feet apart at the nearest point, thus sheet piling could be driven in the spaces between cells in the form of arcs on both up- and downstream sides. These arcs were left open to water flow pending final closure, by driving alternate pile sections only in part. That is, a short piece of piling was driven down to bedrock and similarly at the top a short piece was used to provide a guide for threading the adjoining pile, thus leaving spaces or openings in alternate piles that could be closed later. This piling had only a short distance to go to reach bedrock whereas in driving the original cell walls the overburden depth was so great that it was impossible to reach bedrock.

The material needed for the filter (2) was provided from sources that could be tapped most readily. The lower portion, filled with rock spoil from the excavation, contained very little "fines", thus leaving ample space through which to pass the leakage which at this time, still totaled about 3,000 g.p.m. This rock was covered with a heavy blanket of bank run gravel trucked from a nearby pit. The weight of the blanket was sufficient to withstand hydrostatic pressures at river head and was put in place before any grouting was attempted. Meantime, exploration and experiment with well drilling rigs was going on preparatory to the start of grouting operations.

A "prescription" for grout

Well drills, 4 in. in diameter, were put down at various points (more than 100 holes were sunk) in search of the main channel through which the inflow of water was occurring. These drills found cavities 1 to 3 ft. deep in the general level of the horizontal sand seam. When toe wall and filter were nearing completion grout was pumped into these holes and careful observations were made to determine the best combination of ingredients with which to effect closure. Cement with water was not satisfactory for grouting because it would wash right through before it had a chance to set. The mixture found best of all was the combination of ingredients in the proportions given in the accompanying table. Shavings and sawdust

GROUT "PRESCRIPTION" DEVELOPED AT GRAND COULEE DAM

Sawdust	8 cu. ft.
Shavings (Thin and wispy, from refinishing machines, measured loose)	10 to 16 cu. ft.
Portland Cement (two sacks)	2 cu. ft.
Sand	6 cu. ft.
Lump Bentonite	50 lb.

Mix the foregoing ingredients, dry, in a concrete mixer for about half a minute and then add:

Water	8 to 10 cu. ft.
Pulverized Bentonite (5% by weight, of water)	30 lb.

After adding second part of the batch mix 1½ minutes more.

Product will be a 14-cu. ft. batch resembling wet cement plaster.

were found to be valuable; Bentonite was used extensively and sand was an essential ingredient.

In the first experiments sand was not used and the result was separation of the solids from ingredients in suspension which resulted in plugging the pipe lines. Some shavings went through the filter as much as 125 ft. and appeared at the cofferdam pumps. However, the dosage finally was adjusted to a point where it was believed that a very satisfactory "prescription" had been developed. This is the combination given in the table. The variations in quantities were the result of not always having available the materials for the exact proportions desired and because of some variation in the size or kind of sawdust and shavings. Quantities used in the entire grouting operation were: cement, 12,539 sacks; Bentonite, 125,000 lb.; sawdust, 4,647 cu. ft.; shavings, 6,823 cu. ft.

The work with the drills was highly satisfactory. The main channel of inflow was located after about two days of drill exploration. After grouting was under way the major job of really shutting off the flow was accomplished by the operations in only a few holes. In three days an inflow of about 8,000 g.p.m. was cut to less than 1,000 g.p.m.; subsequent grouting reduced this to 200 g.p.m.

Placing the grout

The first five ingredients mentioned in the table went into a ½-cu. yd. concrete mixer together and were mixed half a minute or more before the addition of pulverized Bentonite and water. Altogether 400 batches were used in the grouting operations.

As this material came from the concrete mixer it had the consistency of wet cement plaster. From the mixer it was delivered some 300 or 400 ft. in a 7-in. concrete pump line discharging into a 14-cu. ft. steel cylinder that served as a supply chamber or injector in the grouting process. The grout was forced into place by air pressure of 35 lb. per sq. in. Some pressure injections of Bentonite and water and some with various combinations other than standard were used. Grouting with cement and Bentonite was done extensively in the filled slope on the inside of the cofferdam where the circular steel cells had pulled away about 2 ft. from the timber crib. In this area the objective was to penetrate and seal the sand seam which had not been seriously disturbed.

The pressure injections made to plug the filter included about 400 batches of ½ cu. yd. each; most of this went in in about three days. With the plugging operation completed and leakage greatly reduced, the operating program was changed into an endeavor to get penetration that would seal off the small leaks. In this penetration work some 10,000 sacks of cement, largely with a 5 per cent (by weight) Bentonite admixture, was put down inside the periphery of the cells. These were chiefly 4-in. holes, some of which were put down below the sand seam. Completion of this operation reduced leakage to an insignificant quantity.

Upstream cell cluster break

When the sudden inflow of water occurred excavation within the cofferdam had reached a stage where trimming had been completed close to the bottom of the circular cell 66 ft. in diameter at the south or upstream corner of the cofferdam. On exposure of the bottom of this cell it was found that a few piles had not reached the rock and that there were several split interlocks. All preparations were made to place a concrete seal dowelled to the rock around the base of the cell. Unfortunately, the inflow interfered with that plan before the concrete could be placed. Water from the inflow seeped into the exposed cell base and when thus saturated the cell filling caused the sheet piling to rip from the bottom to near the top. This break spilled the contents of the cell into the excavated area.

Remedial measures included immediate sloping down of material remaining in the cell and replacement of the original steel sheet piling with a new cell put down all the way to bedrock and then filled with gravel as its predecessor had been. Adjacent to the new cell and just clear of the upstream face of the dam a concrete wall was built resembling a buttress to the river-arm of the cofferdam. This wall, 75 ft. high, has a base width of 20 ft. which decreases after the first lift to 15 ft.; it is regarded as an important factor in supporting the cell cluster at the upstream corner. The 3,000 cu. yd. of concrete in the wall was placed in a single continuous pour made in seven days.

The cell supporting the conveyor-belt tower had settled and tilted badly so that it was necessary to strengthen the foundations of the steel tower. Originally this tower, whose base dimensions are 30 ft. x 40 ft., was erected on concrete piers supported on wood piles. A slight settlement which occurred in September, 1935, lead to the building of four concrete piers poured in sheeted pits driven to bedrock. Since it was not possible to locate these piers immediately under the columns without disturbing the original foundation, the piers were placed just outside the original footings and spanned with needle beams attached to the column legs above the original footings. Pressures and settlement caused by loss of ground developed excessive deflection in these needle beams and necessitated additional support. This was provided by jacking down four pairs of 24-in. well casings, excavating the inside with the aid of a large bit on a well drill and filling the cylinders with concrete. With these additional supports near the mid points of the needle beam spans the steel tower is believed to be safe.

Prospects for high water

Present endeavor is to speed up the pouring of concrete blocks immediately behind the river wall of the cofferdam and thus to provide substantial backing for the cell clusters where trouble has developed. Run off from the Columbia River water shed has been slow this season and by mid-May the river stage had reached only 140,000 sec.-ft. However, the 500,000 sec.-ft. flow for which the cofferdam now is prepared has occurred on an average of only once in 25 years and with the quantity of snow on the drainage basin that will come off this summer it is believed highly improbable that peak flood will reach this figure.

The Grand Coulee Dam contract is being carried out for the U. S. Bureau of Reclamation, Frank A. Banks, project engineer, by the Mason-Walsh-Atkinson-Kier Company; T. J. Walsh, president, C. D. Riddle, chief engineer and M. H. Slocum, general superintendent.

Workability of Concretes and Mortars

by EDW. W. SCRIPTURE

Director, Master Builders Research Laboratories, Cleveland, Ohio.

By considering mobility and cohesiveness as prime factors in workability, the effect of cement, aggregate and admixtures can be evaluated.

IN THE DESIGN and utilization of concrete and mortar first one property, then another, has received the principal attention. The aim has always been the same—a better, more durable structure — but the means through which this end has been sought have varied. A great advance was made through the popularization of the water-cement ratio law, showing the dependence of strength on the proportion of water to cement in the mix. Since, at the same time, many other valuable properties of concrete, such as density and absorption, are dependent on or at least parallel with strength, it became possible to predict and control concrete quality to a considerable extent by controlling the water-cement ratio.

With the water-cement ratio law in mind the tendency to specify drier and drier mixes grew stronger. On the other hand the magnitude of modern projects and the speed of modern construction methods demanded greater rather than less ease of placing, leading to a desire for more water, at least on the part of those directly concerned with getting the mortar or concrete into place. Where these two tendencies conflict, the question of the relation of the water-cement ratio law to workability immediately arises. It has been demonstrated that the water-cement ratio law is not applicable to mixes which are not workable, so that the first consideration in designing or specifying a mix is workability.

Just as for concrete placed by the ordinary methods so for vibrated concrete, the mix must be workable. With vibration it is possible to place, with good results, mixes which flow less rapidly and which may be harsher. If, however, the mixes are too dry or too harsh the same troubles, especially lack of uniformity and density, will result as would come from unworkable hand-placed mixes. Similarly the defects produced by increased water, such as water-gain, segregation, excessive volume-change and lower strength, are as important in vibrated concrete as in any other.

The flow-shear conception

Workability has little significance except in relation to a specific application, but a system for defining and classifying liquids and plastic solids which gives some insight into the fundamental factors involved has been developed by Bingham.[1] The principle on which this is based can

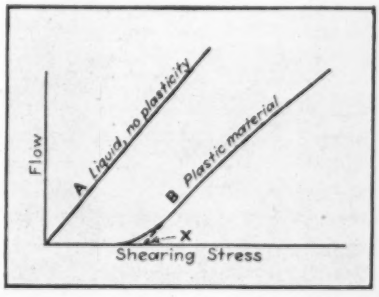


Fig. 1. Plasticity as measured by the shearing stress required to induce flow. The plastic material, curve B, does not begin to flow until a definite stress *x* is applied.

be illustrated by plotting the rate of flow of a given material under increasing pressures as shown in Fig. 1. The upper curve A, which is a straight line, represents a true liquid, such as water, with no plastic properties: The curve passes through the origin, and the rate of flow is directly proportional to the force applied. On the other hand curve B represents a plastic material. Here the mass does not start to flow until a definite minimum pressure is applied, represented by the intersection of the curve with the abcissa at X. (The departure from the linear relation at the lower end of this curve is disregarded for the purpose of simplification.) This intersection is called the "yield point" and indicates resistance to deformation, that is, the quality which enables the mass to retain shape and prevents segregation. (A better term would seem to be "yield value," to avoid confusion with the accepted meaning of the term "yield point" as applied to metals.—EDITOR.) The rate at which flow increases with pressure, that is the slope of the curve, is known as the mobility, which determines the ease with which a mix will flow into place. Here then, are two factors which determine workability in relation to concrete and mortar.

The forces which interact to give the mix certain values for "mobility" and "yield point" are complex and interdependent, but the mobility is primarily dependent on the fluidity of the liquid medium (water) modified by the frictional resistance of the solids (cement and aggregate) while the yield point or resistance to deformation under small loads is controlled by the frictional resistance and the cohesive forces of the solids tending to cause the individual particles to stick to one another.

It might seem that, on account of the limitations of the testing methods and the difficulties of interpretation of the data which can be secured, it would be impossible to make any progress in the study of workability. Bingham's conception of plasticity as made up of mobility and yield point simplifies the interpretation. The slump cone and flow table[2] measure the resultant of the two factors, mobility and resistance to shear, and since the relation between

the two is not constant they do not serve as absolute indices of workability. They do measure consistency fairly well over a limited range and consequently can be used to indicate mobility. Various tests have been suggested which attempt to express workability by a single quantity and for that reason have been successful only over a limited range of consistency or with mixes of fairly familiar design. Several means of measuring segregation have proved fairly satisfactory and a suitable procedure for determining "water-retaining capacity" is available. Cohesiveness can be observed qualitatively, as the condition which the mason calls "fatness" or "butteriness," by judgment of the "feel" of the mix by hand. The results obtainable with a given mix handled in the manner in which it would be applied in the field may be observed with reference to ease of placing, tendency to segregate, honeycombing, water-gain, surface finish, and internal texture. All the different observations can then be assembled and evaluated in terms of mobility and cohesiveness. Thus comparisons can be secured between different mixes if these are at all similar, and to a certain extent quite dissimilar mixes can be compared. Certainly it becomes possible to determine the effects of small changes or additions.

What are desirable qualities?

With the conceptions described it is possible to form some idea of the qualities required in mixes for different purposes. It is fairly obvious that freedom from segregation is desirable in all concretes and mortars. In mass concrete or in any case where the area of the section is large compared to the depth, a high degree of mobility is not required although a certain minimum is necessary. This minimum will be less in vibrated concrete. Since in this type of work concretes with low flows are used, the tendency to segregation will be small and the yield point need not be high. Furthermore, water-retaining capacity is of minor importance in these drier mixes placed in large masses. Harsher, less plastic concretes, such as would be entirely unsuitable for other applications, will be entirely workable.

With thin sections, or where considerable quantities of reinforcing

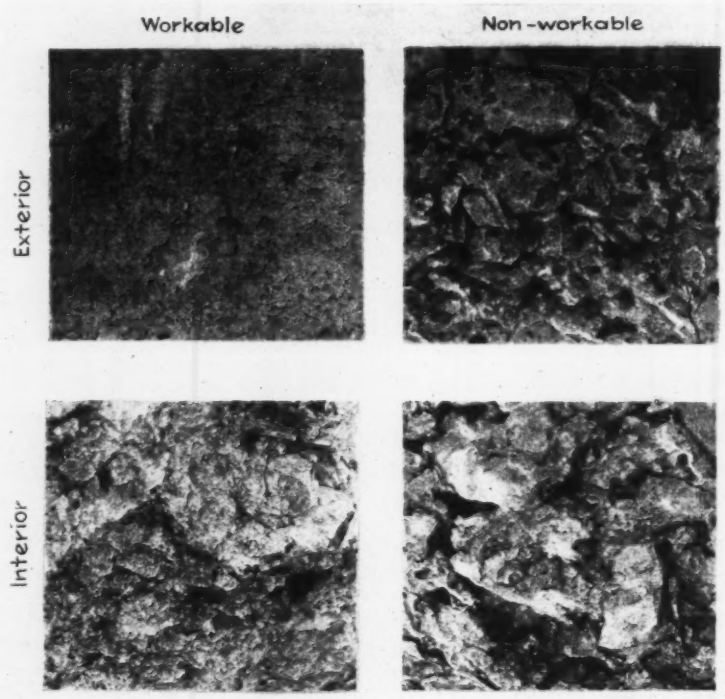


Fig. 2. Differences between workable and non-workable concretes of the same mix are not hard to see. The difficulty arises in measuring the differences.

are included, a high mobility is essential in order to fill the forms and to flow around the reinforcing. Since the concrete is retained by forms, a high yield point is not necessary except insofar as required to prevent segregation. Some water-retaining capacity is desirable to minimize water-gain, but it need not be very great if the forms are tight.

For patching and similar work where the concrete must be built up without forms, a sufficient mobility, depending on the shape of the space to be filled, must be present but a high yield point is also essential, permitting the concrete to hold together. High water-retaining capacity is desirable to prevent drying out.

Similarly among mortars: for floor toppings high mobility is not important but a moderate degree of "fatness" is desirable to permit satisfactory finishing. Providing proper precautions are taken to prevent absorption by the base, great water-retaining capacity is not vital. For thin coatings on vertical surfaces mobility is undesirable but a high degree of cohesiveness (high yield-point) is essential. Owing to the difficulty of insuring complete saturation of the vertical surface, a considerable water-retaining capacity is usually desirable. For mortars which are gunned into place mobility is not required; since they can be applied at very low water content, they will usually be sufficiently coherent, but water-retaining capacity is still to be sought. In contrast, for grouting in confined spaces, very high mobility must be attained, but cohesiveness and water-retaining capacity are not important. Finally, the properties essential to good brick mortars are perhaps the most exacting and most difficult to provide. They should have a very substantial degree of mobility to permit ease in laying up. They should also be coherent and buttery to insure filling of the joints and good contact between the brick and the mortar. The tendency toward segregation should be low but this is more important with the less porous bricks. Water-retaining capacity should be high with porous bricks and becomes less essential as the porosity of the bricks decreases.

It will be seen that each concrete or mortar mix should be fitted to the special purpose for which it is to be used, by varying the properties.

Assuming good workability as compared to an unworkable or difficultly workable mix, many of the properties of the finished structure will automatically be improved. Greater homogeneity or uniformity will be secured, and full strength will be attained. Density will be increased, absorption and permeability decreased. Water-gain, the tendency of water to separate from the cement paste and rise to the top, will be diminished, resulting in a reduction in the formation of laitance and of air-pockets under aggregate particles which constitute points of weakness. The ultimate advantage to be realized from these improvements in the individual properties is greater durability and resistance to weathering in general, especially to freezing and thawing and to corrosion.

Roles of mix components

Workability variables are primarily the components of the mix, cement or other cementitious material, fine aggregate, coarse aggregate, water and any addition for one purpose or another. It will be seen from the foregoing discussion that three components of the mix, the water, the fine aggregate and the coarse aggregate, increase mobility. As they do so at the expense of cohesiveness, excessive proportions of any or all of these will lead to mixes which are unworkable due to harshness and the tendency to segregate. On the other hand, only one component, the cement, promotes cohesiveness but this is the most expensive part of the concrete and, with the mixing water, it causes volume change. The objective, then, in designing a mix is to use as much aggregate as possible with as little cement and water as possible and still produce a workable concrete of the required strength and density.

The cementitious component may affect plasticity in two ways: chemically, by reaction with water, and physically, depending on its physical state. In general, greater fineness would be expected to decrease mobility but to increase cohesiveness. With respect to portland cement the chemical composition does not vary widely, so that the effects are usually small, although some special cements, as the portland-puzzolans, which seem to take up more water, may have an appreciable influence. Lime, as compared with cement, tends to take up large quantities of water. Thereby the plasticity of the type denoted by the expressions "fatness" or "butteriness" is increased but mobility or flow is lowered. Lime also increases water-retaining capacity, but there are wide variations among different limes.

The importance of the aggregate lies in the relations of the various sizes and their proportions to the amount of cement in the mix, that is, the design of the mix. The ultimate object in designing a mix, whatever theory of designing may be used, is a certain minimum strength (depending on structural requirements), maximum density and economy. The last requires that the proportion of aggregate to cement shall be as large as is consistent with the required strength and with workability. Fortunately the mix design giving maximum density also corresponds fairly well to maximum workability. In general, larger maximum size or increased proportion of coarse to fine aggregate increases flow but makes the mix harsh. Conversely, higher proportions of fine materials, sand and cement, decrease flow but make the mix more cohesive or "fatter." At some point these opposing tendencies reach an optimum.

Addition of water, above a small minimum required to wet the solid particles, increases mobility but decreases cohesiveness. In a concrete (or mortar) mix a certain degree of mobility must be attained to permit placing, and this may always be reached by adding water. Any water above that required for the hydration of the cement, however, is undesirable. In relation to workability, increased water promotes segregation, non-uniformity and watergain.

Effect of additional materials

After appreciating the importance of workability and surveying the general situation the natural question arises: Is it possible to do anything more to improve workability than to select materials carefully with respect to their inherent nature and physical form and to combine them in the most suitable proportions? A great number of materials have been suggested as additions to mortar and concrete for one purpose or another, and it goes almost without saying, that any material added will have some effect on workability, large or small, good or bad. The more common types of such materials may be grouped roughly in six classes as shown in the accompanying table.

Although the various additions to cement mixes are here considered primarily from the viewpoint of their influence on workability it is not possible to confine the discussion to that one property alone since some of them have very marked effects, good or bad, on other properties of concrete, which might either recommend them for or bar them from use in concrete without regard to their function as plasticizers. It is, therefore, necessary to consider briefly their effects on strength, density, volume-change and similar properties.

Finely divided admixtures

Class I, probably the best known, is made up of a large number of finely divided, insoluble solids such as diatomaceous earth, talc, pumice, fly ash and even finely ground sand. In general they are characterized by the lack of any great tendency to combine with water although they may absorb water in fine pores. They are divided into two sub-groups on the basis of their ability or lack of ability to combine with lime, in other words on their puzzolanic activity. Their function is to supply additional fine material to the paste of cement and water in which the aggregate move; to a certain extent serving the same purpose as cement insofar as workability is concerned.[6] Since they increase the viscosity of the paste they add to its cohesiveness and decrease mobility; in this they play much the same role as the finest fractions of the sand. The more finely divided these materials are, the greater will be their effect for a given weight.

While in the paste portion of the mix, these "fines" always play the same part, their effect on the concrete as a whole varies with the design. In a mix which is deficient in fine material, either because the available sand contains insufficient fines or because the mix lacks cement, they will improve cohesiveness. They will not increase mobility to any

EFFECT OF VARIOUS ADDITIVE MATERIALS ON WORKABILITY

Type of Addition	Examples	Effect on			Other Effects
		Mobility	Cohesiveness	Strength	
I. Finely divided solids (which do not hydrate)					
a. Inert	Talc	Decrease	Increase	Neutral	
b. Puzzolanic	Trass	Decrease	Increase	Increase	Corrosion Resistance
II. Finely divided solids (which hydrate)	Cement, lime	Decrease	Increase	Variable	Water retaining capacity Cementitious value
III. Stearates	Ammonium Stearate	Slight Increase	None	Decrease	Waterproofing
IV. Electrolytes	Cal. chloride Cal. sulphate	Slight Increase	None	Variable	Acceleration Retardation
V. Protective colloids					
a. Organic	Glue, casein	Increase	Sl. increase	Decrease	
b. Inorganic	Silicate gels	Increase	Sl. increase	Neutral	
VI. Dispersing agents	Alkylated naphthalene sulphonic acid salts	Increase	Increase	Increase (in some cases)	

considerable extent or will actually decrease it, but their added cohesiveness will permit increase of mobility by the addition of more water without objectionable segregation or harshness. In such mixes their general effect on strength and density will be beneficial because the mix thereby approaches more closely a design for maximum density. Usually, owing to the necessity for additional water, they will increase volume-change.

It hardly seems justifiable to state that the same end can be reached by the addition either of these finely divided solids or of cement. As far as workability is concerned this is probably true to a limited extent. But where the mix already contains sufficient cement to produce the desired strength but lacks workability, it would seem to be more advantageous to secure the proper workability by the use of fines which are less subject to corrosive attack and which contribute less to volume change than does cement, especially those fines which do not entail the use of much additional water.

With mixes which can be designed with the proper proportions of fines from the sand and cement, the addition of these finely divided materials will not have a beneficial effect on workability. They will, it is true, increase cohesiveness but the concommitant decrease in mobility must be compensated by the addition of water. This lowers strength, increases volume change and decreases density, since the additional fines are over and above those required for maximum density. The same is true, only more so, of mixes which are already oversanded or carry excess fines.

There are two exceptions to the conclusion that fine materials should not be added to mixes which already have sufficient fines for maximum density. Where it is necessary to fill forms in which much fine detail is involved or where an especially smooth finish is desired, as is the case in some architectural concrete, a mix with what would have, for any other purpose, an excess of fines, gives better results. In concrete exposed to corrosive attack, puzzolanic materials will contribute to its resistance, so that such fines may be used even though not required by the size grading. It may be added that they contribute to strength and density in mixes in which inert fines do not; with respect to workability, they behave precisely in the same manner as any other fines.

Limes, clays, cements

Class II consists of finely divided solids which exhibit a tendency to take up considerable quantities of water. Arranged more or less in the order of the magnitude of this tendency, these include cement, clays, lime and bentonite. The functions of cement with respect to workability have already been discussed; the other materials in this class behave similarly but in a much higher degree. Lime will take up much more water than cement and, therefore, adds more effectively to cohesiveness. It is the common means of producing "fatness" in brick mortars. Clays behave in a manner similar to lime, some showing less tendency to take up water and others more. In fact, in some parts of the country clays have been substituted for lime in brick mortars with practically the same results with respect to workability, strength, shrinkage and other properties. Bentonite is a clay with a relatively enormous capacity for water and as such has an extraordinary effect on workability.

The same principles apply to these water absorbent fines as apply to the previous class. In mixes having the correct proportion of fines or an excess, their influence is detrimental. In mixes lacking fines, they may be beneficial. A point of superiority of the previous group of fines is their insolubility in water and other solutions, whereas lime and a portion of cement are soluble under suitable conditions. Cement, of course, adds to strength, lime has little strength value, clay and bentonite have practically none.

The effect of soaps

A common addition to mortars and concrete has been a stearate or some similar fatty acid salt, that is, a soap. These have been intended for waterproofing, but there is some reason to believe that their effect on workability, not generally recognized, is more important. They dissolve or disperse in the water of the mix and lower the surface tension. Also they are probably adsorbed on the cement particles (or actually combine with them) acting in some measure as protective colloids. The result of this action is, to increase mobility, possibly slightly to increase cohesiveness. Insofar as they increase both mobility and cohesion, they improve workability; but unfortunately the effects obtainable with stearates are rather small. Considering their primary object, that of coating the pores of the concrete with a water repellent substance so that ingress of water is prevented or retarded, their use is probably justified. But *large* improvements in workability cannot be expected.

Various electrolytes, that is soluble inorganic compounds, have been added to cement mixes for various purposes. Primarily they have been used either to retard or accelerate the set. Among the retarders, calcium sulphate, which is added to cement

clinker at the mill, is the most common. Among the accelerators, calcium chloride has had the most widespread use. Others include sodium silicate, potassium silicate, potassium carbonate, aluminum chloride, ammonium chloride and others. Just what the salts enumerated above will do with respect to workability is not very well known but there is good evidence to show that calcium chloride, in the proportion commonly used for accelerating, will improve workability[7] to a small degree.

Glue, tannin, sugar

Protective colloids of organic origin, which include as typical examples tannin, glue, gelatine, casein, agar-agar and many others, have a considerable effect on workability. While sugar is not, strictly speaking, of this class it behaves in a quite similar manner. One characteristic of these compounds is that they take up water very readily, swelling to large volumes if the quantity of water is limited and, with more water, dissolving or dispersing in it to form a more or less true solution. Another related characteristic is that they are all composed of large molecules, large at least, in comparison with those of most inorganic compounds.

They are adsorbed on or combined with solid particles, such as cement. The first effect of this action is to increase mobility. The degree to which this may occur is truly astounding; a little glue (or sugar) added to a stiff cement mortar will cause it to flow freely and a concrete mix with a slump of 1 in. with a little sugar added, will acquire a slump of 3 to 5 in. The effect on cohesiveness is not as remarkable, but probably exists. Here is a remarkable contribution to workability, but unfortunately it is unusable because most of these materials practically destroy the setting properties and strength of cement. This is true of sugar, glue, gelatine, casein and agar-agar, although the reason is not entirely clear. Tannin does not appear to have a detrimental action of this kind and even seems to improve strength, but it is much less effective in improving workability. It has been used, probably to advantage, in the manufacture of cement.

Similar protective colloids of inorganic origin are found among the gelatinous hydrated oxides of metals such as iron and aluminum, various hydrated silicates, and alumino-silicates. These have a similar action in increasing workability but do not cause the detrimental effect on strength. By increasing mobility and to a limited extent cohesiveness with these insoluble gelatinous compounds, the workability of a mortar or concrete can be improved without affecting the size relations of the solid ingredients of the mix. Consequently, the beneficial effects of greater workability will be secured, whether the mix design is one lacking in fines, having an excess of fines or just the proper proportions. The effect on workability is, however, rather small.

Dispersing agents

A final group of materials somewhat similar to protective colloids is composed of organic dispersing agents which markedly increase mobility and also increase cohesiveness. Some of these compounds have an injurious effect on the strength and others tend to foam, thus trapping air and causing voids. On the other hand, a few of them seem to have neither of these disadvantages and consequently offer a means of improving workability without disturbing the size relations of the mix or otherwise injuring the concrete.

Conclusion

An attempt has been made to show that workability is one of the most important properties of concrete or mortar and that without it the potential value of other properties cannot be fully realized. If this somewhat elusive quality is analyzed and broken down into the two components, mobility and cohesiveness, it becomes possible to approach the problem of improving workability on a rational basis even though the methods of measuring at least one of these components are inadequate.

Paradoxically, the constituents of a concrete mix which impart workability are precisely those which impair the properties of the hardened structure, such as strength, density, volume constancy and durability. This is especially true of water, so that the problem is resolved largely into one of securing maximum workability with minimum water. After selecting the best and most suitable materials in the way of cementitious material and aggregates, it is possible to secure a marked improvement in workability, compared with that obtainable with an arbitrary mix such as 1:2:4, by careful design to give just the right proportions and size grading of each ingredient. A mix so designed also shows advantages with respect to the qualities of the finished concrete.

By going outside the usual components of concrete—cement, aggregate and water—it is still possible to effect substantial improvements in workability by the addition of certain auxiliary agents. For mixes which lack fines, because of local conditions or for economic reasons, the addition of either inert or puzzolanic fines is advantageous. Where a very high degree of "fatness" is required, as in brick mortars, additions or substitutions for cement of lime or clay are necessary even though this is done at the expense of the other properties of the mortar such as strength. Finally a number of materials of a colloidal nature are available which will very greatly increase workability, especially with respect to mobility, without interfering with the design of the mix and with beneficial effects on the properties of the finished concrete. If properly selected these offer a means of securing the advantages of workability such as ease of placing and uniformity without an increase or even with a reduction in the amount of water required, so that strength, shrinkage, durability and other qualities are greatly improved.

Workablity References:

1. Bingham E. C. Fluidity and Plasticity (1922)
2. Journal Am. Concrete Inst. Vol. 2. No. 5 Jan. 1931, p. 420 Smith & Benham, p. 439 Lyse & Johnson
3. Rock Products 35 No. 18 (1932) Palmer & Parsons
4. J. Am. Concrete Inst. Vol. 3 No. 6. Feb. 1932 p. 419 Powers
5. J. Ind. & Eng. Chem. Vol. 27 No. 1 p. 97, Levi S. Brown
6. J. Am. Conc. Inst. Vol. 3 No. 4 Mar.-Apr. 1934, p. 325 McMullen & Powers
7. Bur. of Std. J. of Research Apr. 1935 p. 499 Paul Rapp
8. Ind. & Eng. Chem. Vol. 28, p. 963 August, 1936, H. L. Kennedy.

Checking Torrential Floods

Los Angeles County has spent $64,500,000 during the past twenty years on construction and engineering studies leading up to present federal works costing $20,000,000 which form but the initial stage of a $70,000,000 program

Los Angeles County can confidently claim one of the most difficult flood-control problems in the country. Topography, volume and occurrence of rainfall and occupancy by a large city and numerous tributary towns and settlements call for extraordinary variety of design and construction. Mountains and ridges border and penetrate the land except on the ocean side. The drainage is by the Los Angeles River, its large tributary the Rio Hondo, the San Gabriel River and Ballona Creek, each fed by many branches, arroyos and washes from mountain and ridge slopes and all taking courses generally south to the ocean. The rains are torrential and when they fall all these streams, commonly dry or of little volume, become torrents carrying quantities of soil and boulders, scouring the channels and flooding lowlands. Flood comes as suddenly and fiercely as from a bursting dam; control means regulation at dozens of points by many kinds of structures.

Present situation

Local attention began to be directed formally to this flood problem about 23 years ago, and since then under successive administrations and engineer heads various flood-control structures have been built and many hydrographic and other studies made, and a comprehensive flood-control plan has been worked out. This work has all been done with local money. In 1935 the Los Angeles County Flood Control District made application to the Works Progress Administration for financial aid and it was granted under conditions.

The federal grant was made for specific items of control work—not for a comprehensive flood-control plan. It was approved July 10, 1935, amounted to $13,869,000 and carried three major conditions: (1) That the Los Angeles County Flood Control District make a cash contribution of $3,500,000, furnish all rights-of-way and assume all damages; (2) that the work be prosecuted by the War Department, under the direction of the Chief of Engineers, and (3) that a minimum of 90 per cent of the personnel on the work be obtained from the relief rolls of Los Angeles County.

The WPA project as approved consisted of 14 items, but owing to the revocation in December, 1935, of $4,000,000 of the federal allotment four of the project items were deleted. Some additional allotments have been made from time to time, and to date $16,044,000 has been allotted by the federal government, and $3,840,000 in cash had been contributed by the Los Angeles County Flood Control District.

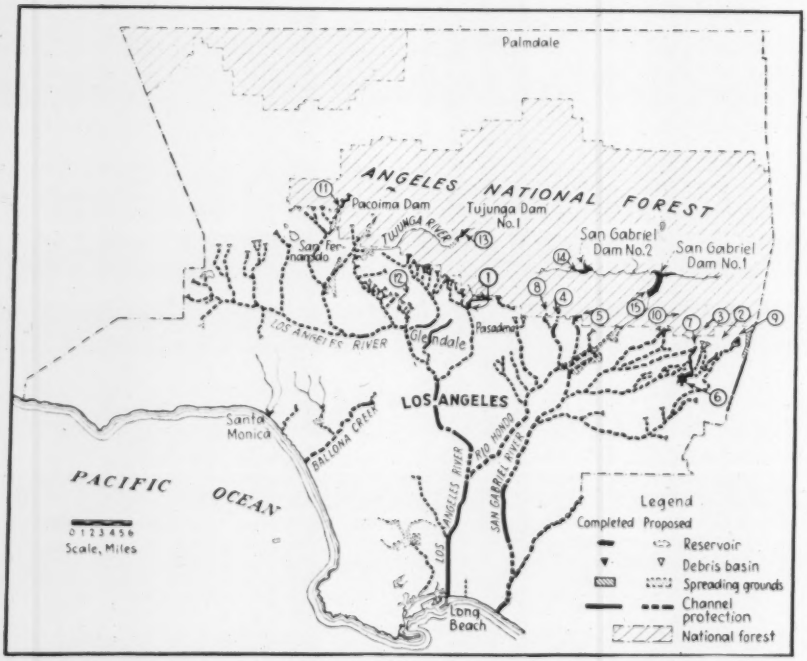


Fig. 1. Flood control in an area of 2,800 sq.mi. of Los Angeles County involves detention dam, debris basins, open and covered channel and flood spreading-ground planning of notable ingenuity.

Local program forms a background

In order to indicate the relation of the present ten items of federal work to the control project as a whole, this article outlines the work previously planned and carried out by local financing and administration beginning in 1914. It has been a work of the first magnitude in flood control, of which the present federal operations are a continuation.

As already indicated, studies looking to the planning and construction of a comprehensive system of protective works have been in progress in

Fig. 2. Carefully placed paving on a levee of the Los Angeles River forms a part of the flood control plan.

Los Angeles County since 1914. Under the direction of the Los Angeles County Flood Control District, over $64,500,000 had been spent at the end of 1936; this is in addition to federal funds. The district's program for constructing storage dams now is nearly completed and extensive work has been carried on in channel improvement, construction of debris basins, study of underground basins and building spreading grounds.

Plan and progress

Initial activity on a county-wide program dates from the disastrous floods of 1914. Popular reaction at that time resulted in passage by the state legislature in 1915 of an enabling act authorizing the formation of a district "to provide for the control and conservation of flood, storm and other waste waters and for the protection of harbors, waterways, public highways and property." Then followed a long period of planning, programming and some construction, culminating in 1924 in a bond issue for $35,300,000 and the organization of the district to direct expenditure in developing and carrying out a comprehensive, county-wide plan of flood control. From that time until now, work on the plan has been continuous.

Unfortunately, because of some natural difficulities and a good deal of scandal, much of the publicity about the district's progress has centered around San Gabriel Canyon. In engineering interest, however, less publicized features of the original program plus later additions are of greater importance, including as they do comprehensive planning for flood-water conservation and flood protection throughout the county. A review of the work in San Gabriel Canyon was published in *ENR*, Jan. 24, 1935, p. 113; the following is a summary of the district's work as a whole.

At the beginning it is important to understand that flood control problems in Los Angeles County have become greater rather than smaller as the work has proceeded: First, Los Angeles and its neighboring cities have grown very rapidly and the much larger total area of roofs and streets has increased the rate of runoff and hence the flood peaks; second, land has increased in value and many new residential districts and high-priced orchards have developed, putting a higher premium on flood protection. In two decades property valuation in the county has multiplied by six.

Rainfall and runoff

Rainfall in Los Angeles County varies widely with location and elevation. Long-time averages show variations from 10 to more than 40 in. according to location. This variation is indicated by Table I, which gives the record at three key points in the district: Redondo, on the ocean shore, represents the minimum precipitation; Los Angeles is a typical station in the coastal plain, and Opid's Camp is about the maximum for the mountain area.

Topographically the district divides itself into two parts: (1) a mountainous area on the north of about 1,600 sq.mi. including a portion of the San Gabriel mountain range, steep and precipitous and rising to elevations of 10,000 ft., and (2) the relatively smooth and gently sloping foothill and valley lands containing some 1,200 sq.mi. that begin at the southern edge of the mountain range and extend to the Pacific Ocean on the south and west. On this wide sloping plain are Los Angeles, Pasadena, Hollywood, Long Beach and other cities, and total population now is nearly 3,000,000.

In the mountain region the canyons are so steep that reservoir sites are few and small, but fortunately because of the flashy nature of the floods large capacity is not necessary for regulation. Much of the catchment area lies below the reservoir sites, which places particular importance on adequate channels for flood runoff. Thus flood control and conservation requirements naturally divide into two parts: (1) storage and debris dams in the mountains and (2) well defined flood channels in the low

lands together with spreading grounds for getting the flood waters into under-ground basins.

Because of the very steep slopes of the mountain area that terminates abruptly in the valley lands, there has been an ever-increasing problem in the control of debris which is carried from the canyons by the first floods following denudation of the foothills by fire or other causes. Enormous damage was caused by the large percentage of debris in the heavy runoff of New Year's Day, 1934, in which a precipitation of 17 in. in 48 hours was recorded (*ENR*, April 5, 1934, p. 439).

In general, the flood-control program contemplates taking the peaks off the floods by storage reservoirs at the foot of the mountainous slopes which constitute the northern portion of the district's area and, wherever possible, releasing the flood waters in such a way as to replenish underground supply. To aid in this plan a study was made of the location and nature of the impervious strata which constitute underground storage basins (*ENR*, Nov. 28, 1935, p. 733). Excellent results have attended replenishment operations in this coastal plain; in the San Fernando Valley the city of Los Angeles has developed a regular routine of replenishment and can gage accurately the time involved and percentage of water recovered when measured flows are distributed into large gravel deposits (*ENR*, May 28, 1936, p. 779).

The district delivers water to spreading grounds below several of the storage dams, usually on the cone at the mouth of the canyon, at the following rates: Pacoima, 70 sec.-ft.; Tujunga, 50 sec.-ft.; San Gabriel, 500 sec.-ft.; Big and Little Dalton, 25 sec.-ft.; San Antonio, 100 sec.-ft. A total of 650 acres of spreading grounds now is operated by the district and during the 1937 spring runoff 100,000 acre-ft. have been released from reservoirs and spread at rates that would permit percolation into underground basins.

Work accomplished

The twelve storage dams, on which a large part of the district's expenditures to date has been made, are all in service except the largest one, San Gabriel No. 1, scheduled for completion next year. These structures are listed in Table II and their locations are indicated on the map.

Channel improvements have included the straightening and lining (where necessary) of natural streambeds. In some cases reinforced concrete lining is used; elsewhere shotcrete is put in or levees are built and faced with concrete, shotcrete or riprap. More than 70 miles of permanent channel improvement of various types has been constructed by the district in the locations indicated by solid lines on the accompanying map. Where funds have not been available for permanent improvement, temporary protection has been provided by earth banks behind wire fencing held in place with pipe or piles. In some cases the fencing is laid on the levee slopes with or without rock ballast. Work of this type is estimated to have a life of only five years. About 110 miles of channel has been protected by these temporary improvements. Proposed extensions of the permanent channel improvements, as they had been planned by the district, are shown on the accompanying map.

TABLE I—RAINFALL AT THREE LOCATIONS IN LOS ANGELES COUNTY

	Los Angeles	Redondo	Opid's Camp
60 year extended normal, inches	15.24	10.37	42.55
Min. recorded, inches	5.28	5.32	20.34
Winter	1876–77	1924–25	1923–24
Max. recorded, inches	38.18	15.69	89.33
Winter	1883–84	1934–35	1921–22

The directing personnel of the district, which has undergone numerous changes since original organization, now includes: C. H. Howell, chief engineer; H. E. Hedger, senior assistant chief engineer; Paul Baumann, junior assistant chief engineer; W. B. Ream, office engineer, and O. C. Eiland, office manager.

Future is federal control

So much for the two decades of local flood control activity, and now federal planning is to take control. The Federal Flood Control Act approved June 22, 1936, contains an item adopting as a federal project the construction of flood control works on the Los Angeles and San Gabriel Rivers at a cost not to exceed $70,000,000 exclusive of rights-of-way.

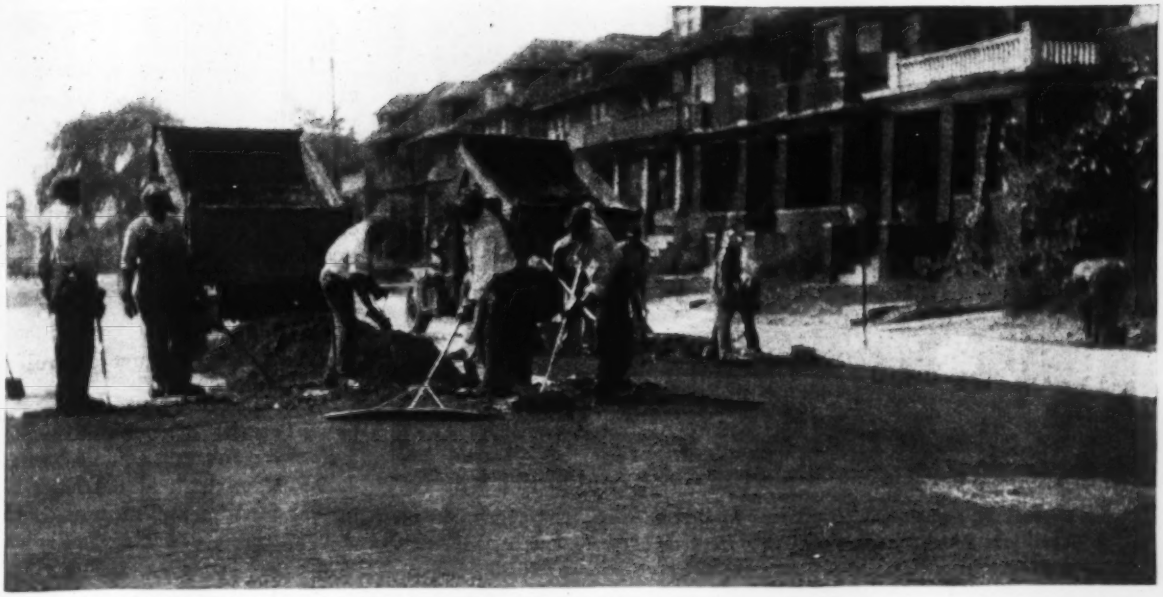
Under this authorization, plans are being prepared in the Los Angeles District Office, Corps of Engineers, U.S.A. to continue the flood control work in Los Angeles County as a comprehensive plan, and to carry the plan to completion as funds become available. The project is under the direction of Major Theodore Wyman, Jr., as district engineer.

(An article to be published soon will describe the design and construction features of the ten items of work now being carried on by the army engineers at a cost of about $20,000,000.)

TABLE II—FOURTEEN STORAGE DAMS HAVE BEEN BUILT BY THE LOS ANGELES COUNTY FLOOD CONTROL DISTRICT AND ANOTHER IS APPROACHING COMPLETION

Name	Location on Map	Year Completed	Type	Height Above Foundation (feet)	Reservoir Capacity to Crest (acre-ft.)
Devil's Gate	1	1920	Gravity conc.— arched	130	6,957
Live Oak	2	1922	Gravity conc.— arched	80	275
San Dimas	3	1922	Gravity conc.— arched	127	1,690
Santa Anita	4	1924	Variable radius	230	1,149
Sawpit	5	1927	Constant radius	162	540
Puddingstone	6	1928	Earthfill	182	20,012‡
Puddingstone Diversion	7	1928	Earthfill	34	323
Sierra Madre	8	1928	Constant radius	90	76,472†
Thompson Creek	9	1928	Earthfill	103	996
Big Dalton	10	1929	Multiple arch	170	1,175
Pacoima	11	1929	Variable radius	372	11,201
Sunset	12	1929	Variable radius (cone)	50	32,000†
Big Tujunga No. 1	13	1931	Variable radius	251	7,460
San Gabriel No. 2	14	1934	Rockfill	280	14,372‡
San Gabriel No. 1	15	1938*	Rolled fill	370	62,000

* Now under construction. † Primarily debris dams; storage capacity in cubic yards. ‡ 7 ft. below crest.



HAND SPREAD HOT MIX IS RAKED AND LUTED TO PERFECT PROFILE; THE OPERATION SHOWN IS ON TIREMAN AVE.

Controlled Quality in Asphalt Paving

by CHARLES L. SHATTUCK

Assistant Chemical Engineer, Department of Public Works, Detroit, Mich.

Detroit street officials set up controlled uniformity of asphalt paving mixtures as an absolute essential and improve their plant and laboratory to secure it

Detroit is known as an asphalt-paved city; today 85 per cent of its paved streets are asphalt. Its experience too has been long—a round half century. In 1904 it took the radical step of setting up its own plant for producing asphalt paving materials and organized its street department for pavement construction. Since then step has followed step as asphalt paving science and art have advanced until a year ago the time came to take a stride beyond all previous standards of precise materials and construction control. This step is the subject of the following article on paving practice. Another on asphalt plant will follow soon. —EDITOR

THE Detroit street department lays stress on the rigid uniformity of the mixtures that it uses in its asphalt street paving. This is not a spasmodic notion, it is a conviction that has grown up through a half century of experience and to appraise it properly some account of this experience is a necessary foreword. At the start, remember that Detroit is an old city and had a tradition of solid and sound public works long before an automotive age had stretched its boundaries wide from the river that gave it its first commercial importance. Asphalt paving began half a hundred years ago and has continued ever since. Some of the past has to be known to understand the present.

City takes control

Detroit's first asphalt pavement was laid on Ferry Ave., West, by the Barber Asphalt Co. in 1887; it amounted to about 8,000 sq. yd. (2 in. thick) and was constructed on a natural-cement base. Since that date, asphalt construction in this city has steadily increased and of the total yardage of paved streets to date (32,000,000 sq. yd.) 85 per cent is sheet asphalt or asphaltic concrete on concrete base.

Practically all asphalt construction was by contract until 1904; in that year the city purchased an asphalt plant and erected it on city property located on the west side of the city at Michigan and 19th streets. The plant consisted of two small units, each capable of mixing 1,000 lb. batches of paving mixture, all aggregates being proportioned by volume. Clarence A. Proctor, who had been in the employ of the district government, Washington, D. C., on pavement construction, was engaged by Detroit to take charge of all asphalt construction. He supervised the erection of the two units mentioned, systematized plant and street work and started Detroit off with its municipally-owned paving unit which has, under his direct supervision, grown to be one of the largest in the country, representing an investment of about $500,000.

In 1910 two additional units of the same size were purchased and installed alongside the original ones on

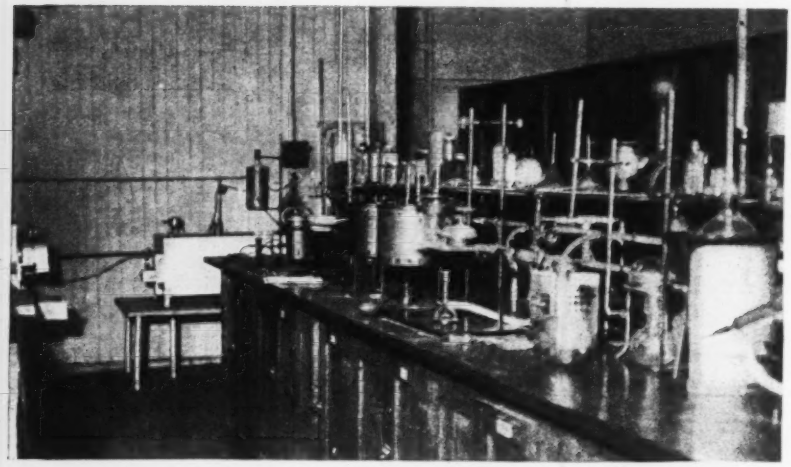


Fig. 1. Control of asphalt paving mixture in Detroit street paving starts in the laboratory which checks every step from tank car to finished pavement.

the west side and in 1925, in order to keep up with the rapidly growing demand for paving, the city purchased two larger units (2,000 lb. mixers) and erected them on its property at French and Lynch roads, on the east side of the city. With both east and west-side units in operation, construction costs were lowered appreciably and production was increased to take care of the continual demand for street improvement. Most of the work, however, was resurfacing and repairs, the majority of the new construction being let by contract.

In 1935, competitive bids were taken for a large modern unit to replace two of the units located on the west side which had been in operation for 30 years. This plant, classed as one of the largest and most modern single-unit, hot-mix, plants in the country (4,000 lb. mixer) was erected and put in operation in May 1936, and is capable of manufacturing 80 tons of sheet asphalt paving mixture per hour. Also, bids were asked and received for enlarging and modernizing the two east side units, and this work was completed in March 1937.

At present, the Detroit-owned asphalt plant units can, if necessary, produce 1,500 tons of hot bituminous paving mixture per 8-hr. day, plus about 400 tons of bituminous mixture of the cold-mix type, the latter mix being made by two of the small units previously mentioned. The normal season production for the city is from 750,000 to 1,000,000 sq. yd. (mostly resurfacing of old streets and repair work) in order to maintain the city's 32,000,000 sq. yd. of asphalt. Many of Detroit's asphalt streets are over 25 years old and are in excellent condition today, but other old thoroughfares which had been built for the traffic of 25 years ago and have recently become main cross-town streets, have necessarily been resurfaced to withstand the heavy pounding of modern traffic.

Plant and product control

Detroit's asphalt plant equipment at present consists of: One Hetherington & Berner plant unit, equipped with a 4,000 lb. mixer, and the latest improved features for uniform control of temperature, weighing and mixing (built in 1935); two Iroquois Iron Works plant units (built in 1935) and remodeled and modernized during the past winter to conform with the latest ideas on temperature, weighing and mixing control. These units are equipped with 3,000-lb. mixers, and two Hetherington & Berner plant units (built in 1910) and recently remodeled to handle cold-mixtures. With these plants are machine shops, blacksmith shops, carpenter shop, etc., to service the plant as well as the street equipment.

Experience in Detroit has shown that asphalt paving mixtures no matter how carefully designed, cannot be termed and will not prove to be good mixtures unless uniformly turned out, and this means uniform in respect to temperatures, weighing of ingredients

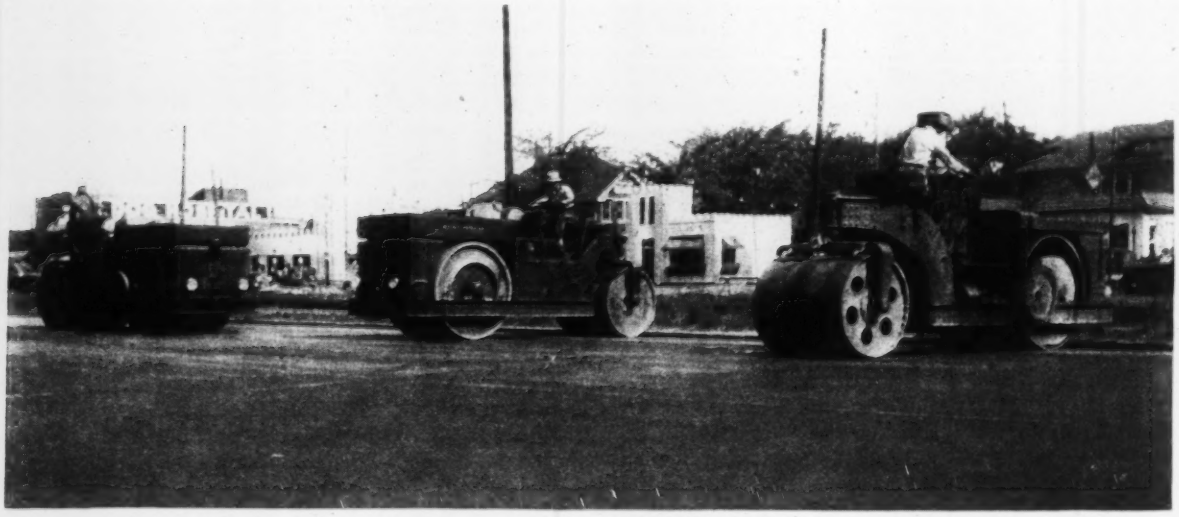


Fig. 2. Rolling is stressed; plenty of rollers are used to travel the street in every direction; the operation here shown is on Woodward Ave., a boulevard of unusual width.

and mixing. The importance of this uniformity cannot be over-emphasized and to achieve uniform mixtures requires, first, the use of modern plant equipment which should be kept in excellent repair, and second, intelligent and constant supervision of all mixture manufacturing and street construction operations. Especial control is exercised as follows:

Temperatures—In the city's plant set-up, the control of aggregate temperatures is carefully checked: The oil burners on the driers are automatically controlled by a mechanical device located in the discharge end of the drier; the feeding of aggregates is controlled by plate feeders, both being watched closely by the drum fireman and varied when necessary to compensate for moisture in the aggregate.

Weighing—Springless, dial scales are used to weigh aggregates and asphalt. A solenoid switch attached to the asphalt-cement scales automatically shuts off the asphalt valve when the correct amount is weighed, thereby doing away with the personal error of this operation, which is so prevalent in most plants. This solenoid switch is being replaced at present with a so-called electric eye and air valve to control the asphalt-cement valve.

Mixing—Time of mixing is controlled by time-locks, equipped with clutch control so that the mixing time can be quickly changed from binder to topping. The time-locks are set so as to give: (1) For binder, 20 sec. dry mix and 25 sec. wet; (2) for sheet asphalt topping, 20 sec. dry mix and 55 sec. wet, and (3) for special asphaltic concrete, 20 sec. dry mix and 55 sec. wet. When mixing sheet asphalt, half the sand is weighed first, then the dust, and finally the remainder of the sand. The mixer tips are arranged to give around-the-box mix.

With eight to ten street gangs calling for material, some ordering binder and some topping, it is necessary to have a plant capable of turning from topping to binder and back again, with a minimum loss of time and no loss of mixture quality through lack of uniformity.

General Control—Beginning operations for the day, stone is fed to the dryer first. When the stone bin is filled, the sand bin is dumped, to get rid of the dust from the stone which has been deposited in the sand bin. The sand is then fed alone, the bin is filled and mixing is ready to be started on either binder or topping, with the proper temperatures for materials and with hot sand of a grading as originally received and not contaminated with stone dust, which would unbalance the first few loads of topping mixture.

A separate small dust bin with conveyor leading to the aggregate weigh box is part of the control system also. This receives all dust from the large bin, thereby controlling this important ingredient, instead of being compelled to take what the dust collector delivers to the hot elevator and thus to the sand bin, where it tends to segregate and cause non-uniform batches.

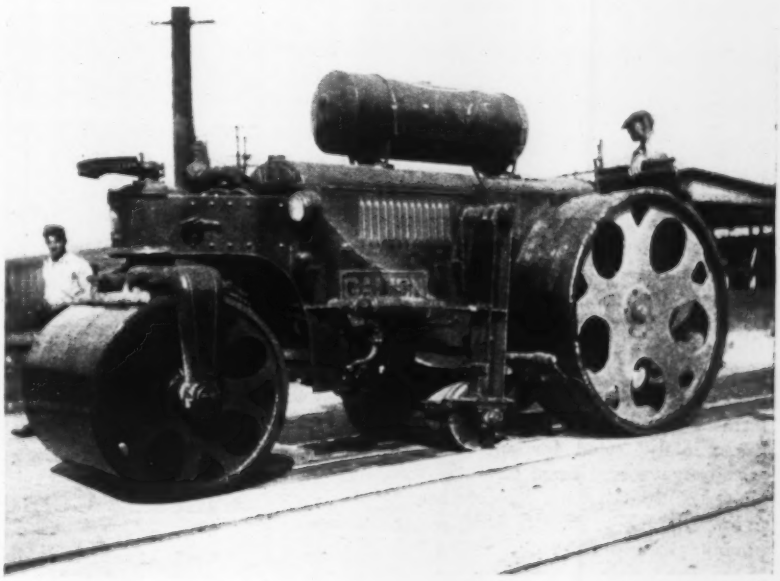


Fig. 3. Rollers with auxiliary center roll are found advantageous on narrow streets and alongside street-car tracks

Paving Methods

A large street-gang for straight work usually consists of two rollermen, four rakers, four shovelers, two tampers, two smoothers, eight laborers and one foreman.

Regular sheet asphalt construction (new) calls for binder 1½ in. thick, compacted, and sheet asphalt top 2 in. thick, compacted, laid on the prepared foundation. On resurface work these thicknesses, of course, do not apply and are varied according to the conditions of the old surface, type and conditions of traffic, etc., in accordance with the opinion of the superintendent of asphalt construction.

Both binder and topping are dumped on the base or old surface in piles and then shoveled to place and raked to proper grade. Both are luted and straight-edged, the straight edge man working in conjunction with the back-man and the roller-man, and correcting any irregularities while the mixture is still warm. Before resurfacing old pavements, they are cleaned thoroughly, all defects are repaired and they are then given a light paint coat of hot asphaltic cement.

Roller equipment varies from 10-ton gasoline tandem rollers to 12-ton three-wheel gasoline rollers. At least two rollers are assigned to each straight gang, and sometimes four, according to the width of the street and the rate the material is being laid. Great importance is attached to long, slow rolling—straight, diagonal and also cross-rolling where the street width is sufficient to make a good cross-roll.

It has been noticed in the past that the freshly-laid dense sheet asphalt mixtures, when rolled thoroughly acquire a sort of surface sheen which is rather slippery when wet. This slipperiness seems to last until traffic has worn off the sheen and exposes the sand grain surface. The customary application of Portland cement brushed over the surface, before the final roll seems only to make this temporary condition worse. Recently,

Detroit has experimented with a special sand which is distributed very lightly over the hot asphalt surface by a small spreading machine, after the rollers have given it a few passes.

Rolling is then continued and buries the sand grains securely in the topping, producing a sort of sandpaper finish, much the same as the ordinary surface after traffic has worn it for a couple months. A sheet surface finished in this manner is non-skid, does not alter the appearance and is highly satisfactory and the sand application costs much less than the Portland cement. This item of construction has not been adopted entirely as yet.

Laboratory control

Efficient laboratory control is absolutely essential to the manufacture of any type of bituminous construction. The bituminous laboratory of the city of Detroit, located at Western Yards, (West Asphalt Plant) is equipped to handle rapidly complete tests on all materials used in the manufacture of bituminous paving mixtures.

Each shipment of the various materials arriving at the plants is immediately tested for specification requirements and must have the approval of the laboratory before being unloaded. Also, several samples of paving mixture from each plant are tested each day, for asphalt content and mineral aggregate grading. Stability tests on the mixtures as turned out are also run daily to check the uniformity of plant mixing and original design stability.

Aside from these daily tests, samples are taken from the different jobs each week, these samples being taken of the hot mixture just before it is rolled. These samples, dated and marked for exact location, temperature when sample was taken, length of time from plant to time dumped and kind of asphalt used in the mix, are saved for research work and tests on the recovered asphaltic cement.

One of the city's special and useful pieces of laboratory equipment is a laboratory twin pug-mill type mixer, built in the plant machine shop. It is motor driven, steam-jacketed, and has capacity of ½ cu.ft. of material, and is used not only in making experimental mixtures, but in research work in conjunction with the stability of various mixtures and on the effects of prolonged mixing on the asphaltic cement.

Specifications for materials are compiled (and revised from time to time) according to observations of materials in service and from data and research work done in the laboratory. Laboratory work is continually being done in an endeavor to provide specifications which will give better materials for paving mixtures and also better or as good mixtures at lower cost.

The average cost of binder and sheet asphalt topping per ton laid during 1935 and in 1936, was as follows: (Does not include repair cuts)

	Binder (for resurfacing —various thicknesses)	Topping (for resurfacing —various thicknesses)
Misc. materials such as roller fuel, paint coats, kerosene, etc.	$0.0600	$0.0690
Plant labor	0.4853	0.4775
Street labor	0.7025	0.6913
Hauling	0.4592	0.4518
Overhead	0.8367	0.8374
Materials	2.3986	3.6432
Total labor and materials per ton laid	$4.9323	$6.1602

Complete records of the kind of materials used in the paving mixtures on the various streets are kept as ready reference, so that the service record of the different brands of materials can be compared. Also, complete cost cards are kept up-to-date showing the total yardage on each street each year, total maintenance each year, total cost of maintenance, maintenance per total area and maintenance per yard per year. These records give a complete picture of the amount of money invested in any particular street, at any period of time and of just how much the maintenance cost increases as age and traffic increases.

Administration and personnel

All bituminous construction is under the direction of Laurence G. Leonhardt, commissioner of public works. The supervising personnel are Jan Schmedding, engineer of street maintenance and construction, and Clarence A. Proctor, engineer of asphalt construction, assisted by the writer as assistant chemical engineer. (An outstanding factor in controlled uniformity of asphalt paving mix in Detroit is a new asphalt plant fitted with every modern appliance for regulating temperature, proportions and mixing time. This plant will be described in an early issue.)

Metals Conference at Boston

THE most recent advances in the knowledge concerning the subjects of fatigue of metals and the effect of high temperatures on metals under operating conditions are now being discussed at a four-week series of conferences and lectures in the department of mechanical engineering of the Massachusetts Institute of Technology at Boston, Mass. The series opened on June 21 and will be concluded on July 16.

Failure of a metal results from repeated or reversed stresses which exceed the fatigue or endurance limit of the metal. A characteristic of such a failure is its occurrence without warning and a nominally ductile metal such as the majority of the steels used in construction work can be made to fracture as if they were brittle metals. Metal subjected to the effect of high temperature over a long period of time decreases in strength, this phenomenon being known as creep. It is evident therefore, that these phenomena are of utmost importance to the designers engaged in various industries.

H. J. Gough, an international authority on the fatigue of metals, of the National Physical Laboratory of England will lecture and A. Nadai and C. R. Soderberg, both of Westinghouse Electric and Manufacturing Company, will lecture on "Creep of Metals". Supplementary lectures and laboratory exercises on the strength of materials will be conducted by members of the institute staff, and frequent seminars will present the latest developments in the allied fields of engineering mechanics.

Formal papers discussing the American and European developments in the fatigue of metals field, the problems fatigue introduces in the electric, railroad, and aircraft industries, the theory of creep, and the problems creep introduces in the turbine, valve, and oil equipment industries will be presented at all-day conferences to be held on the last two days of the program.

Semicentennial of Canadian Engineers

Engineering Institute of Canada celebrates fifty years of expanding service to the profession in a series of notable meetings

THE ENGINEERING INSTITUTE of Canada, founded as the Canadian Society of Civil Engineers in 1887, celebrated the semi-centenary of its inauguration by a week of meetings in Montreal and Ottawa, June 14–19. The original charter of the society was obtained with Royal ascent on June 23, 1887, hence the meetings marked almost exactly the fiftieth anniversary of the foundation of this important national Canadian engineering organisation. The change in name to that of Engineering Institute of Canada took place in 1918 being indicative of a broadening of the scope of the society which then took place; today the institute contains within its membership all classes of engineers and this diversity of membership was reflected in the nature of the anniversary meetings.

The opening session, as noted in last week's issue, was given over to greetings from other societies and to the conferring of honorary membership and awarding of medals. Addresses were delivered at all the functions, principally by leading delegates to the meeting. At the luncheon, held on Wednesday, there were two addresses that call for special note. The first was by A. C. Gardiner, chief engineer to the Clyde Navigation Trust, representing the Institution of Engineers and Shipbuilders in Scotland, and was concerned with the development of Glasgow Harbor and the River Clyde. The review of this remarkable engineering work was necessarily brief, but vivid indeed, tracing the gradual deepening of the river from the time of the first report on the matter, made by John Smeaton in 1755, to the recent successful launching of the Queen Mary, the world's largest liner, within six miles of the center of the city of Glasgow. The constant dredging required for maintaining the channel which now averages twenty feet in depth at low tide, was described as was also the modern equipment of the port, which now includes a cantilever crane capable of lifting 196 tons at a radius of 85 ft.

The second address was to have been given by Harrison P. Eddy whose death had occurred in Montreal a few hours before the opening session. Mr. Eddy's manuscript for his speech was made available and upon being read were found to constitute a remarkable review of "The Next Fifty Years." After pointing out that the engineer always is looking towards the future, his work of the present being based on experience in the past, Mr. Eddy suggested five probable technical developments for the next half century—a greater conquest of space by means of aerial travel, a wide extension of the application of mass production methods, the mechanical development of agriculture in many of its phases, a much greater use of the principles of automatic control, and a more general distribution of the necessities of life with an extension of the availability of what are now luxuries. In the last fifty years, he noted, working time had been reduced by one third, so that in the next fifty years—provided the work of the engineer is properly utilised—one can look forward to a reduction of the average working week to one of twenty hours only. The increased leisure thus made available led Mr. Eddy to suggest that the credit coming to engineers for the mechanical improvements making possible this reduction in working hours carried with it very great responsibilities, especially in the way of education, to which the engineer must respond in no uncertain way. In the development of this professional responsibility, for the creation of educative effort fitted to the proper use of leisure time, Mr. Eddy foresaw an extension of engineering training beyond the ordinary college courses, and a great broadening of the scope of engineering societies enabling them to deal effectively with social, industrial, and economic problems, not only on a national but an international scale.

At the official banquet the Governor General of Canada, Lord Tweedsmuir (honorary member of the institute) delivered a most thoughtful address calling on the engineer not to be oblivious to the claims of beauty especially in his bridge design, grain elevator design being a branch of engineering work in which a new phase of beauty was already vividly expressed.

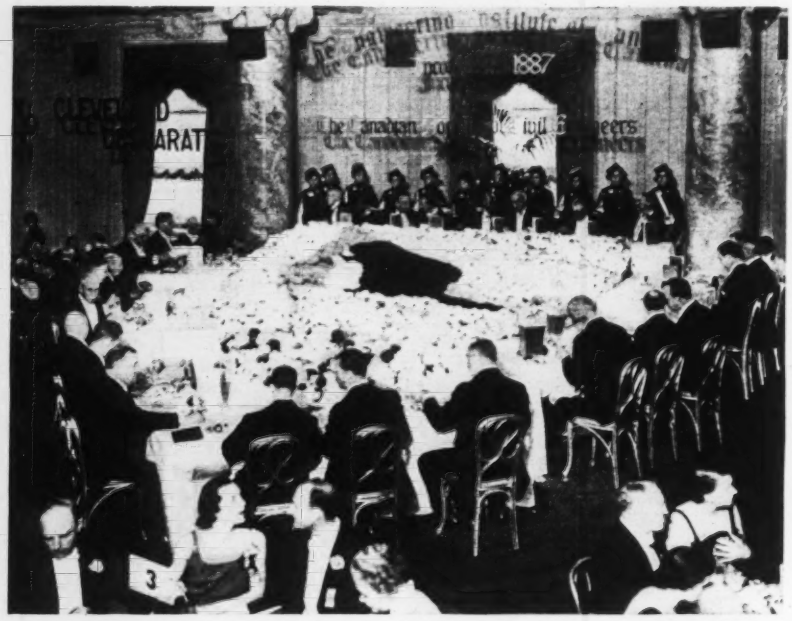
Spoken greetings were brought to the meeting from engineering societies in New Zealand, Australia, and India on special records that were heard over the amplifying system, and notable speeches were delivered by leading delegates, the speech of E. P. Lupfer, vice president of the American Society of Civil Engineers emphasising the international cooperation of the two societies, being outstanding.

Inspection trips

On Thursday visits were paid to all the leading engineering features of the Montreal district, including the harbor, principal bridges around the island, and important engineering works. On the day following, about eighty of those attending the meeting travelled to Ottawa where the Ottawa branch of the Institute was host at a luncheon and dinner, visits being paid to local engineering works of interest. On Saturday all the principal engineers of the Dominion government service were at home to visiting delegates.

Technical sessions

Five technical sessions were held, at which twenty-two papers were presented; an "overseas" session on Tuesday preceded the holding of four sessions on the day following, two being held concurrently in morning



A feature of the Engineering Institute banquet was the shield of the Institute formed in flowers, sloping down from the speakers table to the level of the floor tables, and flanked by tables for distinguished guests. At the table, left to right, are G. H. Mitchell, Sir Alexander Gibb, the Governor General, Lord Tweedsmuir, G. J. Desbarats, President, E.I.C., E. P. Lupfer, Arthur Surreyer and E. A. Cleveland.

and afternoon. No technical meetings were held at Ottawa.

In keeping with its nature as an institute covering all branches of engineering, the papers ranged over many fields of engineering work; detailed comment here is confined to those related especially to civil engineering. M. Mowat, secretary of the Institution of Mechanical Engineers, London, presented the first paper at the "overseas" session, which was a review of the development of British engineering societies commencing with the City Livery Guilds of London. Although these guilds are now not active in the way originally intended, they are still associated with the trade whose name they bear, so that the Founders Company, which appears to have existed since A.D. 1365, may be regarded as the forerunner of most modern engineering societies. The development of these bodies in Great Britain was outlined, special attention being paid to General Mowat's own institution, although the Institution of Civil Engineers, founded in 1818, was given its place as the parent body of all engineering societies.

Industrial zoning was the subject of the second overseas paper, being presented by H. Beaver of London. It contained a brief review of the development of industry in Great Britain and outlined the many measures which the British Government has had to adopt in recent years for the control of industry, more especially in respect to the location of new industries. Great Britain, said Mr. Beaver, has moved very far in the direction of state control of industry, so far in fact that the question of the day for engineers is not whether this is a wise policy or not, but along what lines such control should run. Engineers as a body, he added, should take a lively interest in this whole subject which is, at heart, essentially an engineering problem.

The British Grid system was described in a paper by Johnstone Wright, chief engineer of the Central Electricity Board of Great Britain. Little discussion followed this paper, but the questions which were asked served to show that the paper had cleared up much misconception as to what "Grid" is, and the functions it is designated to fulfil. The Central Board was set up in 1927 as a public authority, reporting to the British Minister of Transport, but operated as a self contained organization outside of all political control. It had four functions: to standardise frequency throughout Great Britain at 50 cycles, to construct the Grid (which is a high voltage system of main power circuits connecting all the main generating systems of the country), to control the operation of these stations, and to supply power in bulk to electrical distributors.

The Grid has made possible the development of isolated Scottish water power schemes, some of which were described, as were also several notable steam power plants in many of which the main problem is the supply of cooling water. This has led to the use of sewage for this purpose in the Hams Hall Station at Birmingham, which is far removed from any large waterway.

Precast concrete

Three papers dealing with civil engineering subjects were presented at a Wednesday session. R. E. Chadwick, president of the Foundation Company of Canada, took as his subject the use of precast units in engineering construction. Basically, Mr. Chadwick's thesis was that in Canada particularly, the use of precast concrete units might well be extended since, taking quality as the first consideration in major construction work, the use of precast units does enable really first class work to be obtained, even in the most difficult locations, and under arduous climatic conditions, while not increasing the cost of the work, the important second consideration, to an undue extent. The paper was largely given over to a concise summary of notable construction jobs featuring the use of large precast concrete units, selected from American and Canadian practice. In view of this experience, Mr. Chadwick suggested that Canada lags behind the rest of the world in the use of precast units.

In this view the author of the paper was sustained by E. W. James, consulting engineer of Montreal, who stated that on examination of a pier at Halifax, N. S., in 1936, it was found that precast piles supporting the structure were all in perfect condition below low water level and that in all cases where upper parts had been added to the piles by concrete cast in place (above l.w.l.) deterioration had taken place to a far greater extent than was evident in the case of the precast piles. Mr. James pointed

out how precast units can be used for the critical part of marine structures, that "between wind and water," and suggested that the possibility of confining precasting operations to the summer months, while placing the units throughout the whole year, had much to commend it.

P. Leclaire, chief engineer of the Montreal harbor commissioners, gave some details of Montreal experiences, observing that for all reinforced concrete work in Montreal harbor a minimum cover over reinforcing steel of 6 in. is always adhered to.

P. B. Motley, bridge engineer of Canadian Pacific Ry., questioned some of the author's conclusions while agreeing with the efficiency of precast construction. As evidence he mentioned some precast concrete bridges built by the C. P. R. in the years 1917-1919, in both Toronto and Montreal, in which units weighing up to 58½ tons were used for trestle construction, easily handled, at costs only slightly higher than steel, with the advantage than since their installation, these precast bridges had cost nothing for maintenance. In a humorous vein, Mr. Motley suggested that large precast work was limited to contractors having the necessary heavy lifting equipment.

Definite doubt as to the validity of Mr. Chadwick's thesis was raised by D. W. McLaughlin, of the Department of Transport, who emphasized that the secret of good concrete, precast or otherwise, is so closely related to the control of the water content that, if this is carefully controlled in cast-in-place work, he cannot see why it should be inferior to precast work.

Winter bridge work

C. J. Mackenzie and B. A. Evans, of Saskatchewan, described the new Borden Bridge, over the North Saskatchewan River in the province of that name, constructed by the Department of Public Works, Canada, in 1935-36 to replace an old ferry crossing. The bridge is 851 ft. long, made up of four short approach spans, two spans of 204 ft., 9 in., and a center span of 213 ft., 6 in., all three main spans being reinforced concrete tied arches. Details of design were given, together with an instructive description of special features of construction. The river piers were put in during the depth of a severe prairie winter, temperatures being as low as −40 deg. F. for ten days, thus necessitating more than usual attention to cold weather concreting methods. All reinforced concrete work in the superstructure was carried out during the following summer months.

Possibly the most interesting part of the paper was a section giving full details of the records obtained during construction as the result of much observation on concrete temperatures, and of the action of the temporary Considere hinges which were built into the center of each of the arch ribs. This latter action was checked in three ways, of which the most reliable was thought to be by measurement of the residual moment carried by the hinges. Observed data checked fairly well with calculated figures based on the arch rib acting as a three hinged arch during construction.

Transport to remote regions

The third paper at this session, presented in the form of a very short abstract accompanied by two reels of cinema film, dealt with freight hauling in the undeveloped territories of Canada, the author being J. B. D'Aeth, of the Fraser Brace Engineering Co., of Montreal. The paper is a comprehensive study, probably the first to be made in such detail, of a subject which has in recent years been of great importance in Canada, as construction operations, following mining developments, have been carried on at increasingly great distances from railroad facilities. Details are given of the more usual methods of summer haulage in the bush, by teams, and by water transport. The major part of the paper is devoted to winter haulage, however, since the bulk of haulage is done during the winter in order to take advantage of the travel then possible over ice and snow roads. A large table accompanies the paper, giving complete cost data with respect to 24 different transport projects, and typical instances are described of the difficulties to be overcome in such work, including the crossing of rapids which do not freeze, even in a Canadian winter, by means of ingenious log bridges. In the case of large winter transport operations, regular trains, consisting of tractor and sleighs with a regular caboose at the end, are now common. Contract prices for such operations range from between 30 to 40 c. per ton-mile, but as evidence of the advance of aerial transport, freight can now be delivered by air for slightly under one dollar per ton-mile, and this figure is still decreasing.

Air transport

Transport featured largely in the proceedings of the remaining technical session. H. B. Bowen, chief of motive power for the Canadian Pacific Ry., read a paper on modern motive power, this being essentially a review of latest motive developments, while J. H. Parkin, of the National Research Council, Ottawa, presented a paper on the North Atlantic Air Service, London to Montreal. In view of the local interest of this subject, the first regular trip being scheduled for the end of June, this paper naturally attracted much attention.

C. D. Howe, Minister of Transport, brought the subject up again at the banquet given later in the week at Ottawa, taking that occasion to make an important pronouncement with regard to the prospective trans-Canada air service, to be started at least in part later in the present summer. Mr. Howe described the preliminary engineering required for the preparation of the necessary groundwork, now reaching completion. Started in the depression years as a relief project, 100 emergency landing fields now exist across the Dominion, not more than 50 miles apart. They are being inter-connected by means of one system of communication and will be served with weather reports from some 900 government meteorological stations.

Mr. Howe stressed the debt owed to the United States, in that Canada was able to benefit by experience of American services. He went on to explain, however, that Canadian planes now carry 60 per cent of all freight handled by air in the British Empire, and about five times as much as the freight carried annually by air in the United States.

This dinner, with its memorable address, brought to a fitting close the meetings of the week which formed a worthy celebration of the landmark in the history of the Engineering Institute of Canada provided by its semi-centenary.

Steel Baffles Stop Sliding Fill

by G. H. ALLEN

District Engineer, Indiana Highway Commission, Vincennes, Ind.

A side-hill-fill slip that had long bothered Indiana highway engineers has been held for three years by a system of buried steel-plate slope-baffles

EARTH slides that trouble roads and railways are quite frequent in southeastern Indiana and this is a story of a bad one that was stopped by simple devices and has been held fast for three years. State Highway 66 at the east city limits of Troy is cut in a hillside; half of the road resting on a bench and the other half on earth overburden and fill. This cut-and-fill was necessary because the Southern R.R. had previously built on the lower bench adjacent to the river. The centerline of the highway is about 130 ft. north of the railroad centerline and 55 ft. higher. Because relocation of the road was impracticable and costly, an attempt was made prior to 1933 to replace the material as it slid away, but this additional fill only aggravated the slide and caused the embankment below it to bulge. While no actual damage to the railroad had occurred up to that time, it was felt that the continual addition of fill would eventually cause the slide to extend to the railroad.

At the time the writer started investigation in the summer of 1933, the road at this point was open to one-way traffic, and the cross section shown by Fig. 2 is typical of the upper part of the slide which extended 220 ft. along the road. As a general practice the highway department investigation of slides includes borings to determine the cause and possible correction by sub-surface drainage, and also possible relocation of the road. As stated before, relocation was impracticable and costly because it necessitated cutting further into a sandstone and shale bluff and this would expose a greater face of material to erosion, and might cause some of the overburden to slip toward the road.

Almost at the first the writer had been approached with reference to the use of a patented (Will Cox, Chillicothe, Ohio) metal fill retainer. After a study of this method of retaining earth and a trip to an installation on U. S. Highway 25 south of Berea, Ky., it was decided to utilize it. This decision immediately eliminated the necessity of sub-surface investigation by borings or pits which would probably have been costly on account of the rock that would be encountered. It was known also that proper anchorage essential to the method could be obtained in the rock ledge at the north side of the road.

Fig. 1. Anchor bars being installed across the road to hold buried baffles to retain the downhill slope of a sliding fill.

General design is simple

The layout plan of the metal fill-retainer installation (Fig. 2) shows the component parts. The anchor bars, which extend from the anchorage across the road and down the slope, support retainer plates which are spaced 12 ft. on centers along the slope. A cone is located at the break in the bank to take the resultant force at this point (Fig. 4).

The design will be reviewed only in a general way. The graphical method outlined on page 897 of the Merriman handbook was used to obtain the loads. The fill retainer was designed to support that part of the fill between 1 on 1½ slope (desired slope) and a 1 on 2½ slope (assumed angle of repose of soil without support). From research paper 329, Bureau of Standards, page 11, it was determined that 0.51 oz. loss per square foot per year would be a satisfactory assumption for open-hearth steel in the type of soil at the site. On this basis sufficient thickness was added to the retainer plates for a life of 60 years and to the balance of the parts for a life of 120 years. This basis of design was used because when a retainer plate fails it can be replaced at a low cost, whereas the failure of an anchor bar would cause the whole device to fail and replacement would be expensive.

Construction methods

A contract for the installation of the fill retainer was awarded Nov. 20, 1933, and was completed Jan. 10, 1934. The anchors for the bars on the north side of the road were placed in concrete in holes drilled into solid rock and proved to be excellent.

After the bars were placed across the road, the fill had progressed so far that the cones and slope bars could be installed. The foreman for the fill-retainer people stated that no compaction was required on the slope; even under the cones where it was known there would be a concentrated load. As this was an experimental job put in under the supervision of the pat-

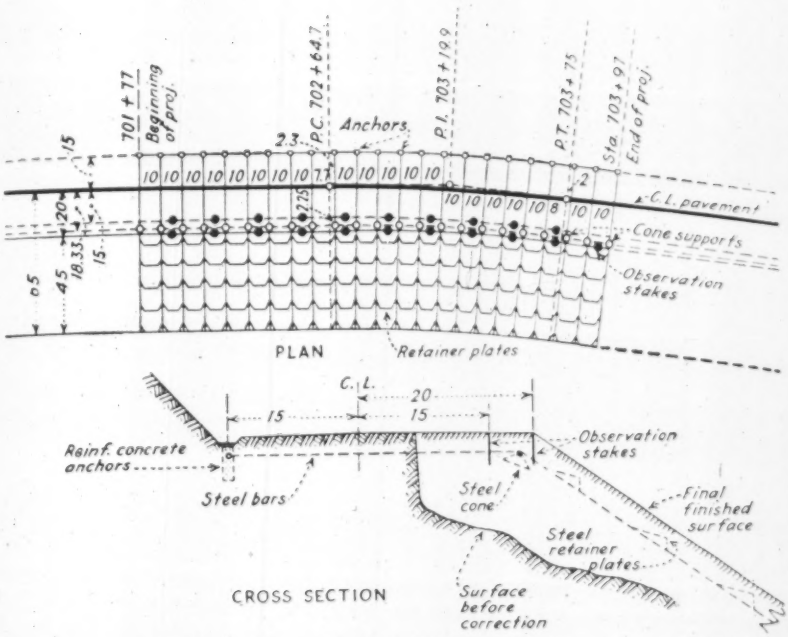


Fig. 2. Design plan of anchors and buried steel-plate baffles installed to hold side-hill fill from sliding.

Fig. 3. Retainer plates installed and ready to be buried with additional slope fill.

entee, it was decided to follow his recommendation.

The balance of the work was a matter of connecting the retainer plates to the bars (Fig. 3) and completing the earth fill over the plates. A 12 in. blanket of dirt was placed over the plates as a cover for vegetation and to provide a counter load to prevent the plates from starting an upward movement under a side pressure. Fig. 5 shows the completed slope which has held its position for over three years and still shows no sign of moving.

The steel was all fabricated at a local structural steel shop and trucked to the site. It was furnished according to state specifications and was sampled in the highway department laboratory when mill-test reports were not available. All parts of the steel work received two coats of asphalt paint before installation and abrasions of paint were touched up after the parts had been erected in position. A machined insert was used at the top of the cones to insure uniform bearing of the anchor bars on the cone.

At the time work was completed long stakes were set 15 ft. and 20 ft. to the right (south) of the centerline (Fig. 2) to take observations of the settlement of the fill. The last readings, taken April 23, 1936, showed such slight settlement that no further observations have been made. This installation has gone through many heavy rains and one very deep freeze during the winter of 1935-36. The maximum settlement near the middle of the installation 20 ft. from the center line was $11\frac{3}{8}$ in. which can be considered as excellent for a loose fill of this height. The shoulder was kept to grade during the settlement and stakes were uncovered to take the readings.

The surface of the slope was eroded considerably before a growth could be started but this was to be expected on an unrolled fill of this type. In a few places the retainer plates were exposed the first year but after vegetation covered the slope no trouble of any kind was experienced. It is the writer's opinion that the full length of potential slide must be treated to prevent an overloading of the end panels by a possible future slide. This installation covers the area at the crest of the hill and possibilities of additional sliding at the end are remote as the highway is on a descending grade each way from the installation.

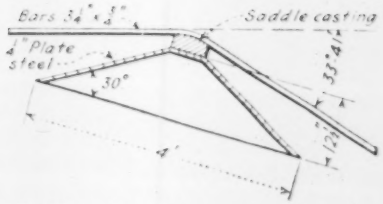


Fig. 4. Steel plate cone that provides reaction for the anchor rods where it bends over the top edge of the bank.

Fig. 5. Completed slope which has held its position for three years and shows no signs of dangerous moving.

FROM FIELD AND OFFICE

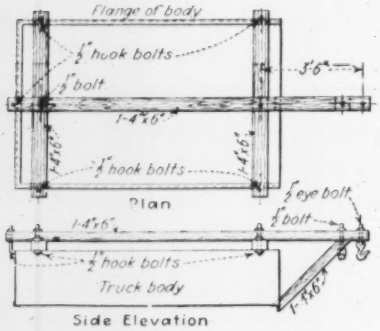
Working problems and time-saving methods . . . Edited by Charles S. Hill

Truck Outfitted To Swing Road Drag

by BEN H. PETTY

Professor of Highway Engineering, Purdue University, Lafayette, Ind.

Old-type road drags can be swung clear of the ground to cross railway tracks or bridges or to be moved to new work by the simple truck outfit shown by the accompanying diagram. To swing the drag: Raise the truck



Frame fitted to a truck to lift and swing clear a drag for travel.

body to dumping position and attach a lifting chain to the front of the drag; lower the truck body to the level, lifting the front of the drag so it can be hooked to the rear frame of the truck; retilt the body of the truck and pass a chain over the bolt holding the hook and fasten its ends to the sides of the drag frame towards its rear end; level the truck body again and so lift the drag clear of the ground. If the truck body is too light to lift the drag, a counter-weight is applied to the front end.

. . .

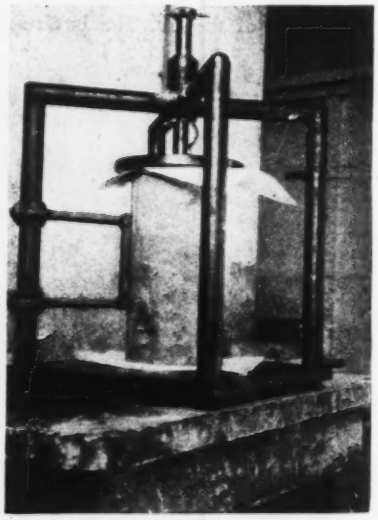
Concrete Cylinder Capping

by N. M. FINKBINER

Engineer of Materials, Oregon Highway Commission, Salem, Ore.

A test cylinder capping device used in the Oregon state highway laboratory makes unusually simple the operation of securing perfectly parallel and planes. As shown by the illustration the bottom plate or base is a machined piece of metal 1 in. thick by 15 in. square and is immovable. The movable head is an 8-in. circular metal plate which slips through a sleeve held by the posts, one at each corner which rise straight for about 18 in. and then bend at right angles toward the center. The four ends of these supports are attached to the sleeve so that the movable plate above is exactly parallel to the base below. The upper plate has about a 9-in. drop, and is prevented from slipping through the sleeve by a nut on the upper end. By the use of Ford connecting rods, two from each post on one side, two metal pieces 6 x 2¼ x ½ in. are held exactly perpendicular to the base, and close enough together so that a 6 x 12-in. cylinder can be rested against them.

In capping a cylinder, a piece of paper is placed on the under plate, and the plaster of paris paste placed on it. The cylinder is then placed on the paste, so that it is resting evenly against the two extending plates. Plaster is then put on top, another paper laid over it, and the movable head is then pressed down firmly and the excess plaster squeezed out. After a few minutes for hardening, the top plate is raised and the capped cylinder is slid out.



Accuracy of the capping of test cylinders is assured by use of this device.

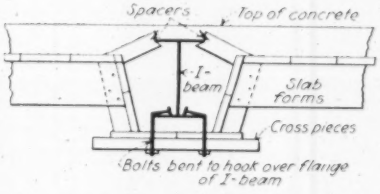
. . .

Hung Forms for Floor Slabs

by K. B. HUMPHREY

Sayreville, N. J.

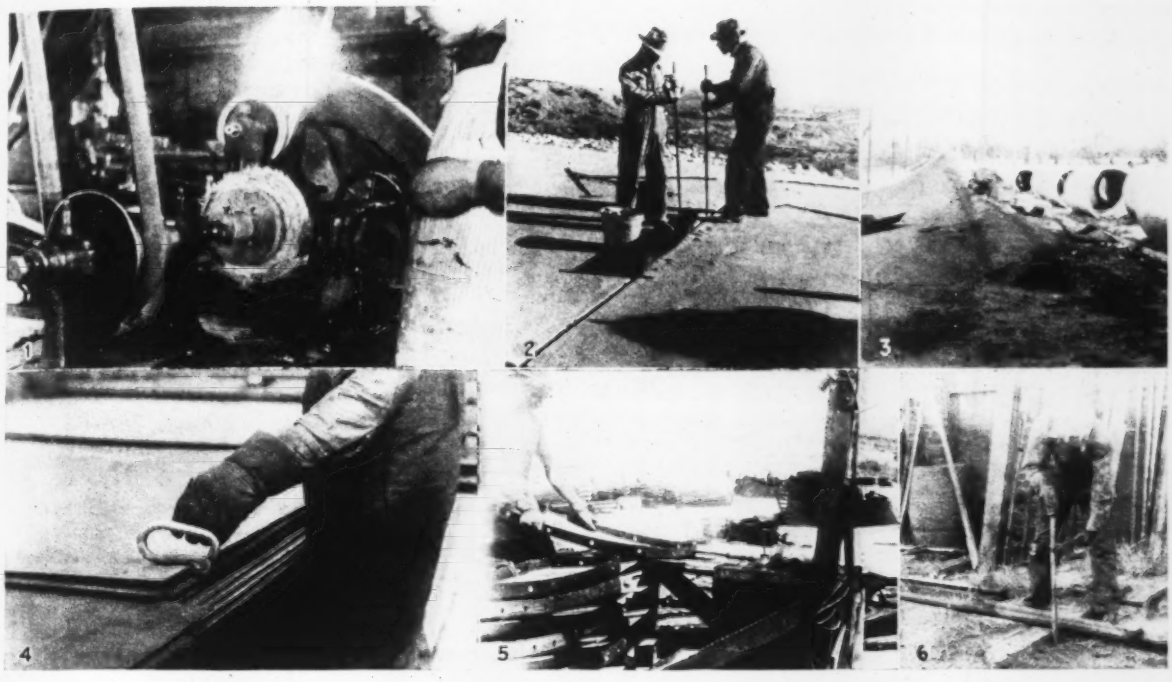
A simple hung form used in floor construction where a ceiling height of 34 ft. and obstructions below made shoring from the ground expensive, is shown by the accompanying sketch. Two pieces of board are cut to the proper length and nailed together side by side by cross pieces at close enough intervals so that the weight of the wet concrete will not cause undue deflection between them. Two bent bolts are placed through



I-beam hung forms save the use of high scaffolding.

properly spaced holes at each cross piece which is left longer than the width of the boards to facilitate handling. The reinforcing around the beams is placed before the bottom boards are placed. The slab forms are made in sections of such size that they can be handled easily. In the building referred to enough forms were made up to cover two parts of the roof. On the average, it was found that this type of movable hung forms could be used four times before repairs and replacement of some of the lumber were necessary.

The procedure was as follows: The bottom boards were pulled up by a rope at each end and two men on the beam twisted the bolts around and hooked them, the bolts being placed ready in the boards before hoisting them up. The slab form sections were then pulled up and put in place supported by the bottom boards. Spacers as shown were placed at intervals to hold the forms exactly in place and were removed after the concrete was poured up near the top level. After the first section of floor was poured another set of forms was set up in the next bent. By this time it was possible to remove the first set



CAMERA MEMORANDA OF CONSTRUCTION AIDS

1. By stitching together several thicknesses of canvas, cut into disc shape, and compressing them between wooden discs in a small lathe, an excellent buffer is secured, which imparts a fine edge to wood working tools used in fine form work.

2. A wedge-shaped trough, with open bottom, is used to guide cotton seed hulls, impregnated with asphalt, into pavement expansion joints; the hulls are tamped in with spud bars.

3. During trenching for a water line, ground which was not frozen too deeply was thawed in the manner shown; a fire was kindled under a long arch of old sheet metal, over which loose dirt was thrown to hold in the heat.

4. In manufacturing reinforced concrete pipe for a large water main the contractors used steel hooks like that shown to protect the men's hands from injury in moving large steel sheets from which the reinforcing cylinders were fabricated. The tapered end of the hook is inserted between the sheets, then a slight twist of the hook grips the sheet sufficiently to move it about.

5. Drilling bolt holes in the flanges of liner plates, for a tunnel job, was expedited by using a small bench, with an electric drill strapped down horizontally at one end of it; the plates were shoved against the drill.

6. The hands may be protected against splinters and hammer bruises by using a small pair of tongs to hold wooden stakes while driving them; metal pins can be held in the same way.

of forms and move them to the third bent and so on. The forms were removed from a light scaffolding built up underneath and moved about to suit. The bolts were left in place and proved to be very handy for supporting pipe, conduit and other things.

• • •

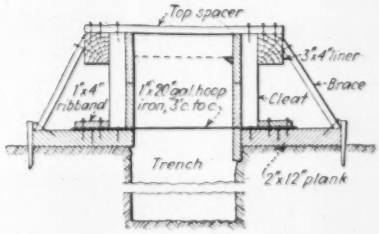
Forms for Grade Beams

by G. W. MAKER

Aberthaw Co., Boston, Mass.

Forms for grade beams in concrete building can be reduced in cost where the ground is reasonably firm by the construction shown by the accompanying sketch.

The ground along the beam line is roughly graded and a 2 x 12-in. plank is laid on each side of the line of the beam and is held about to location by small stakes at the outside edge. The planks are kept separated by temporary cleats and the trench is excavated between the planks which serve as a guide. The planks are then brought to exact line by straps of 1-in. by 20-gage hoop iron securely nailed to prevent spreading. The upper form is set in place supported by the plank as shown. By this method forms below grade are eliminated and the plank on either side protects the trench sufficiently to prevent more than minor cave-ins during the placing of concrete.



Form for above-ground part of concrete grade beam in firm earth.

The sketch shows the outside form carried down below the plank. This is done where the finished grade outside the building is likely to come below the rough working grade. In such cases, a strip of the necessary width is nailed to the edge of the plank quite independent of the upper form, which is assembled as a unit.

$3 to $5

paid on acceptance for items suitable for the pages of From Field and Office.

Desert Water Tanks

by GLENTON G. SYKES

Research staff, Southwestern Forest and Range Experiment Station, Tucson, Ariz.

Storage basins composed of gravel and sand confined behind small dams have been in use for more than a century to conserve water in the semi-arid regions of the Southwest

IN THE more arid parts of the Southwest, especially in the semi-desert regions of southern Arizona, the question of a small but dependable water supply is of prime necessity for human life and activity. Depending upon the location, the rainfall in this region is seldom more than 5 to 12 inches yearly, and over 50 per cent of the annual total occurs during the rainy season of July, August, and September. The dryness of the climate, together with the extreme heat during several months of the year, make it almost impossible to conserve water in any type of open pond or reservoir. To meet these unusual conditions a unique type of water bed or reservoir—called the "desert sand tank"—was introduced more than a century ago and is still used today.

Essentially a sand tank consists of a dam or other impervious structure built across a streambed or large desert "sand wash," preferably at a place where there is a rock outcrop or where the stream bed is confined within a rock-bound channel or small canyon. The dam is well bonded to the bedrock and channel walls, the object being to intercept all water moving down as drainage in the form of subflow. Desert streams usually carry heavy flows during the summer rains, grades are steep, and large quantities of material are transported by the swiftly moving torrents. Consequently the impounding basin behind a dam soon fills with coarse sand and gravel. It is in the voids of this material that water is stored.

The percentage of voids in typical stream-washed material in this region is from 25 to 30 per cent, thus when the impounding basin is full, at least one-fourth of the cubical contents is available for water storage.

Quantity of water stored

In computing the quantity of material that may be stored behind a dam of given height and length, the deposited material is not considered as lying on a horizontal plane. Based upon measurements and experimental tests, it has been found that the angle of deposition will vary from 1 to 4 per cent, depending upon the character of the bed load. The distance above the dam to which deposition will occur under a given set of conditions is given by the expression,

$$L = \frac{100h}{s_2 - s_1}$$

Where—

h = height of dam in feet

s_1 = per cent grade assumed by silt

s_2 = per cent grade of original stream bed

L = distance above dam in feet

Taking a typical example, assume a dam 10 ft. high, 25 ft. long, built

Fig. 1. "Sand Tank" in the desert foot-hill country of southern Arizona. Some of these unique "tanks" have been used for water supply for more than 100 years.

in a stream bed of 4 per cent slope, with deposition grade of the silted material 2 per cent. Under these conditions, the volume retained by the structure when the basin is full is some 1,700 to 2,200 cu. yds. Assuming 25 per cent voids in the sands and gravel, there is a water storage capacity of about 116,000 gallons.

Evaporation loss minimized

The fact that the water is retained in a relatively deep bed of sand is a distinct advantage. Evaporation losses are very much reduced and the water is kept free of contamination from animals and insects. Evaporation from a wet body of sand or soil is carried on through the agency of capillary action, that is, the movement of moisture to the surface through minute tubes or passageways. The pore spaces in coarse sand and gravel are too large for the proper working of capillary movement, with the result that when the upper layers of a sand bed dry out they act very much as an insulator, tending to prevent further loss through evaporation. It is mainly due to this fact that the sand tank is a success as a water conservation receptacle in desert regions.

In the design of a sand tank some provision must be made for drawing off water as it is needed. Sometimes this is done by merely laying a perforated pipe in the bed of the basin above the dam. Such an arrangement, however, is liable to become clogged with fine sediment and rust and will probably give trouble. A better method is to construct a shaft or collecting well against the upstream face of the dam, the lower wall sections of which are usually built of large loose-jointed rock, the bottom being left open. This arrangement permits free percolation of water into the well and the draft pipe is led directly out of the sump.

There are a great many of these structures throughout southern Arizona and northern Sonora, Mexico, some of which have been in operation for domestic and stock use for perhaps a hundred years. One of the principal examples is the old dam above La Osa Ranch at Sasabe, Arizona. The history of this structure is somewhat obscure, but it is said to be nearly 150 years old and up until comparatively recent years it furnished the main water supply for a flourishing ranch.

Propellers Work in Tubes On Columbia River Boat

Shallow draft for barge is obtained by placing propellers within the hull

A RIVER BOAT new in design and purpose arrived at Portland, Ore., recently to begin a specialized freight service on the Columbia River between Portland and the Dalles. The boat is unusual in that its propellers operate in longitudinal tubes within the body of the vessel.

If success attends the venture, more craft of the same type are expected to make use of the improved navigation conditions resulting from construction of Bonneville Dam. The boat is equipped for carrying gasoline and oil on the upstream trip and grain (either in bulk or in sacks) on the return, thus providing an all-water service from tidewater at Portland to upriver points.

The Inland Chief, as the new boat is called, was built in Seattle expressly for this service. Although it has a length of 190 ft., and a 40-ft. beam and is powered by twin diesel engines rated at 450 hp. each, it is of less than 1,000 tons registry because the draft had to be shallow. With a pay load of 825 tons the draft is only 7 ft.

No damage to the propellers would result if the boat were to ground in shallow water because they operate in upward-curving tubes that extend aft from the engine room. The propellers, 5 ft. in diameter, are set at such a level that the lowest point reached by the rotating blades is 2 in. above the level of the hull bottom. There also is 2 in. clearance between blades and top of propeller housing.

When the boat is loaded lightly the water suction in the tubes constitutes an addition to the live load equal to the head differential between tube arch and river water level. However, this suction load decreases as draft increases; it disappears altogether when the draft reaches 5 ft. 4 in.

The pool above Bonneville Dam probably will not be filled until sometime this fall. Meantime arrangements have been made to begin gasoline delivery service by means of a 5-in. pipe line over the dam to auxiliary barges. Until the pool is filled the "Inland Chief" is to receive its load from tank steamers at Portland, proceed to Bonneville Dam, there connect its delivery hose to the pipe over the dam and pump its cargo into barges moored above the dam, whence they can be towed to the gasoline terminal provided at the Dalles. Later it is planned to extend service to points farther upstream.

The "Inland Chief" has been chartered by the Interstate Commerce Commission as a common carrier, is entitled to a joint rail and water rate with connecting railroads and can quote rates 10 to 20 per cent lower than all-rail freight tariffs. Other freight services proposing to use vessels of still shallower draft plan to operate between Portland and the points beyond Umatilla, Wash.

. . .

Chicago Asks PWA Loan For Subways

Mayor Kelly of Chicago on June 9 filed an application with the PWA for a loan or grant of $50,000,000 to construct a subway system in the Loop area. He stated that if present plans for unification of elevated and surface transit facilities do not work out to permit private operation of proposed subways, the city will operate the subways itself.

The Mayor stated the preliminary design work is well advanced and can be completed in time to permit submission of a definite proposal to the voters in November, with work to be started in the winter of 1937-38.

THE WEEK'S EVENTS

Continued from page 7

Waiver of Demurrage Asked In Case of Strike

Acting as a result of the heavy demurrage charges which accumulated on shipments entering Cincinnati for the Laurel Homes housing project as the result of the strike there of building laborers, the Cincinnati Chamber of Commerce has initiated a movement to have the Interstate Commerce Commission waive railroad demurrage charges in cases in which loading and unloading of shipments is held up by strikes.

Letters have been sent to the Association of American Railways, the National Industrial Traffic League, and the U. S. Chamber of Commerce, asking them to support the move.

• • •

Structural Steel Institute Reviews Test Program

The present state of the structural investigation program of the American Institute of Steel Construction is reviewed in a report recently sent to the Sixth International Conference on Steel Development at Duesseldorf, Germany.

The report states that the Institute has completed the tests in progress during recent years on the effect of wind on tall buildings. The equipment used in this work on the Empire State Building at New York City has been dismantled, and the test results, covering wind velocities, wind direction, negative and positive pressure recorded on the 33rd, 35th and 75th floors, the sway of the tower, and the wind stresses in tower columns and girders, will be reported in a paper which will probably be published this Fall.

The Institute has also been interested in a study of the stress distribution in rigid frame knees. This study has progressed to the point where preliminary investigations of two testing specimens, one with the angular knee and the other with the curved knee, have been completed. In addition to these riveted specimens, a fully welded test specimen with an angular knee has been built and is now being tested. Six small-scale Bakelite models are being investigated photo-elasticly, and it is hoped that the relationship of stress behavior between these six models and the full sized specimens can be established.

Tests have been completed on the stress behavior in battledeck bridge floors, and the final report is now being written. It will probably be available in the Fall.

A test program has been established, in connection with the gross area method of designing plate girders, to show the complete stress distribution in all parts of a riveted plate girder. The Institute has under discussion the possibility of a series of tests to begin this fall on the behavior of flange and web splices in riveted plate girders.

PERSONAL

JOHN A. LEE is now superintendent of tunnel operations for the Port of New York Authority.

ARTHUR G. FULLER recently became the first sanitary engineer of Louisville, Ky.

LAWRENCE WATERBURY has joined the staff of Elwyn E. Seelye & Co., New York City consulting engineers.

WILSON T. BALLARD has received an appointment as engineer for the Baltimore County metropolitan district.

R. F. WELLER, district engineer at Lincoln, Nebr., has been appointed chief of the state highway safety patrol.

ANSON J. GERNER, for 16 years superintendent of the Fresno Irrigation District, has been appointed manager and chief engineer of that district.

COL. J. D. ARTHUR, JR. became district engineer of the Huntington, W. Va. Engineers Corps office this week, succeeding Col. John F. Conklin.

S. R. DEBOER, of Denver, was recently appointed consultant for the National Resources Committee of Wyoming, Utah and New Mexico.

H. A. HOBSON, formerly an engineer for the Pennsylvania R. R., has been appointed assistant to the superintendent of the Lake Erie division.

J. P. YARBORUGH, chief engineer for the Meridian, Miss. district of the Works Progress Administration, has resigned to go into private employment.

JAMES BANNON has been appointed Okanogan County Engineer at Okanogan, Wash., to succeed M. P. McCoy, who resigned. At the time of his appointment he was serving as city engineer for Brewster, Pateros, Tonasket and Kittitas, small Washington towns, and as engineer of the Whitestone reclamation district.

FLOYD A. HAMILL, city engineer and commissioner of public works in Butte, Mont., has resigned to engage in private business.

F. R. CURRAN has been appointed city engineer and commissioner of public works at Butte, Mont. He succeeds Floyd A. Hamill.

DEAN W. LOUCKS, formerly connected with the South Dakota state highway commission, was recently appointed state engineer.

W. J. BROPHY, formerly construction engineer in the North Dakota highway department, has been appointed to the newly created office of safety engineer.

R. A. HOUSE has been appointed district engineer of the Lincoln district of the Nebraska state highway department, succeeding R. F. Weller.

FREDERICK A. ALLNER, Baltimore civil engineer, has been appointed a member of the Maryland state board of health.

STEPHEN J. EVERD has been appointed to the newly created post of building inspector for Anne Arundel county, Maryland.

COL. R. C. MOORE, U. S. Engineers, who has been stationed in Kansas City, Mo., has been transferred to Fort Logan, Colo.

LT. COL. MILO P. FOX, Corps of Engineers, district engineer of the First Portland District, has been transferred to Fort Dupont, Del.

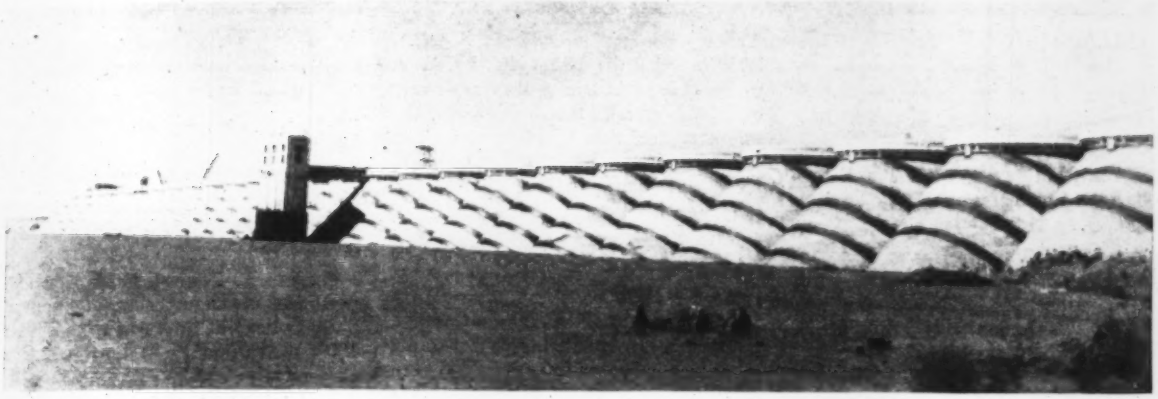
L. M. DYAL, formerly resident engineer for the Alabama highway department, is now connected with the Georgia highway department.

COL. ERNEST D. PEEK, U. S. Division Engineer, North Atlantic Division, New York, has been promoted to the rank of Brigadier General.

MORGAN BARRADALE, since 1930 superintendent of tunnel operations with the Port of New York Authority, was recently appointed assistant to the general manager of the authority.

WESLEY W. POLK, superintendent and chief engineer of the waterworks department of Evanston, Ill., has been appointed director of public works of that city.

LESLIE J. REARDON has been appointed chief engineer of the Brick Manufacturers Association of America, Cleveland. Mr. Reardon leaves a position as resident engineer inspector in charge of



A NEW DAM GOES INTO SERVICE

GATES of Buchanan Dam were closed on the evening of June 1, beginning creation of a new lake on the Colorado River in Texas. Heavy rainfall on the upper watershed prompted earlier closure of the gates than had been anticipated. The water reached a height of 20 ft. the first day, and within 36 hours had forced closure of State Highway 29 between Burnet and Llano, as the old crossing 8 miles upstream from the dam was inundated.

Construction of the dam was begun as an Insull enterprise in 1931, but after the collapse of the Insull interests, it was taken over by the Colorado River Authority, created for the purpose by the Texas legislature.

the PWA engineering staff on the new $3,000,000 water purification plant under construction by the city of Cincinnati.

JOHN W. BURKE, New York consulting engineer, was accorded the honorary degree of doctor of engineering at the recent commencement at Worcester Polytechnic Institute.

RALPH O. PERROTT, Jr., has been named assistant highway engineer of Division No. 3 of the Ohio highway department, succeeding H. E. Pannabaker.

RAYMOND H. REED of Lincoln, Neb., has been appointed superintendent of the Loup River Public Power District's rural electrification division. Mr. Reed was formerly construction engineer for the Eastern Nebraska Public Power District.

CARL V. ERICKSON, who has been assistant chief engineer of the Chicago, Ill. sanitary district, has been made manager of the Urbana-Champaign, Ill. sanitary district, succeeding the late D. H. Radebaugh.

ARTHUR J. CAPELLE, formerly associate construction engineer with PWA on the Evansville, Ind., housing project, has been appointed consulting architect by the Brick Manufacturers Association of America.

LIEUT. CMDR. RUFUS C. HARDING has been ordered detached from his navy civil engineer corps duty at the Mare Island, Calif. navy yard to become public works officer at the Coco Solo, C. Z. submarine base.

B. E. MCCOWN, resident engineer for the Ohio highway department at Ironton, Ohio, for the past seven years, has been appointed to the engineering laboratory of the U. S. Bureau of Reclamation at Denver.

JOHN W. KUSHING, research and testing engineer with the Michigan state highway department since 1933, has been appointed vice-president in charge of engineering by the Highway Steel Products Co. of Chicago Heights, Ill.

LIEUT. CMDR. PAUL J. HALLORAN of the navy civil engineer corps has been ordered to duty in Tutuila, Samoa, as public works officer, and to additional duty under the island government. He has been at the Quantico, Va. marine barracks.

• • •

Grand Coulee Concreting Beats Boulder Record

The long-standing record for concrete placement, 10,400 cu. yd. in one day at Boulder Dam, has been surpassed by a wide margin at Grand Coulee where the hustling concrete crews placed 12,400 cu. yd. on June 14. On the three previous days the eight 4-yd. mixers ground out from 11,500 to 11,900 cu. yd. so the high mark is no fluke. However, this is just a starter, for the contractors plan a schedule of 440,000 yd. per month for the remainder of the job, an average of 15,000 cu. yd. daily. To date more than 2,500,000 cu. yd. has been placed in the dam and the structure now contains 80 per cent of Boulder's total yardage. Grand Coulee Dam is a year ahead of schedule, and present plans contemplate completion of the low dam, which will be the foundation for the high dam, by next January. Mason-Walsh-Atkinson-Kier Co. is the contractor.

Scott Is Named Member Of Power Commission

John W. Scott, Indiana lawyer, has been named by President Roosevelt to be a member of the Federal Power Commission to succeed Herbert J. Drane, of Florida, whose term expires June 22, 1937. Mr. Scott, who is 44, is prominent in affairs of the American Legion and is national vice president of the Veterans of Foreign Wars. For the past two years he has been special assistant to the Attorney-General, devoting his efforts to the many cases which have been brought against WPA power loans.

Mr. Drane, 74, has been in public service for over forty years as a member of the Florida legislature, member of Congress from Florida, and a member of the Federal Power Commission. It is understood that he is withdrawing in favor of a younger man because the duties of the Commission under the Holding Company Act and other prospective legislation are expected to increase considerably in the future.

• • •

Roadbuilders Will Meet In Cleveland

The American Road Builders Association will hold its 36th annual Road Show and convention Jan. 17-21 in Cleveland, Ohio. The decision to meet in Cleveland was taken by the board of directors on the recommendation of the organization's joint exhibit committee.

The association announces that reservations already coming in from manufacturers indicate the possibility of a record road show.

CALENDAR OF MEETINGS

ROYAL SANITARY INSTITUTE, 48th Congress, Birmingham, England, July 12-17.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Detroit, Mich., July 21-24.

AMERICAN WATER WORKS ASSOCIATION, Central States Section, Dearborn, Mich., Aug. 18-20; North Carolina Section, Wilmington, N. C., Aug. 26-28.

• • •

License Examinations

SOUTH CAROLINA: examinations for professional engineers and land surveyors, July 13, at the State Office Building in Columbia, S. C.

BRIEF NEWS

A SHORTAGE of skilled building trades workers has been noted in Montreal, where building operations, especially residential work, have reached the highest volume in years.

CONTRACT has been awarded for construction of the new Chevrolet axle and motor plant at Buffalo, N. Y. to Bryant and Detwiler Co., Detroit, Mich. Building plans and specifications were drawn by Albert Kahn, Detroit architect. Cost of the plant is understood to be about $3,000,000.

KEYSTONE DAM construction will be begun by Morrison-Knudsen of Boise, Idaho, the General Construction Co. of Seattle, Wash., and the Utah Construction Co. of Salt Lake City, Utah, who have been awarded a joint contract by the Central Nebraska Power and Irrigation District on their bid of $2,736,000. At the same time the District awarded a contract for construction of control structures for the irrigation canal to the Inland Construction Co. of Omaha on its bid of $564,000.

EAST AND WEST SLOPE interests in Colorado are united in an effort to seek federal appropriations to start the proposed Grand Lake-Big Thompson water diversion project this year. The plan involves two dams and storage reservoirs on the Colorado River near Grand Lake, on the Western Slope, and a diversion tunnel under the Continental Divide. Representatives of the Western Slope have tentatively accepted a draft of an agreement prepared by Eastern Slope interests, calling for 24,000 acre-ft. of water to be withheld from diversion to satisfy demands of Grand County.

APPROVAL of plans and specifications for construction of the remainder of the $4,800,000 irrigation project of the Willacy-Hidalgo County Irrigation District has been granted by PWA. A $1,600,000 loan and grant is already on hand, and with the remainder of the full sum available when needed, it is expected that a considerable block of land will have water available for irrigation by the end of the year.

A HYDRO-ELECTRIC PROJECT with an installed capacity of about 54,000 hp. is to be built on the Yadkin River near Tuckertown, N. C. by the Carolina Aluminum Co. of Pittsburgh, according to a declaration of intention filed with the Federal Power Commission. The proposed project consists of a gravity type concrete dam about 1,320 ft. long and 93 ft. high, a reservoir with a surface area of 3,032 acres and usable storage of 23,000 acre-ft., and a power house forming an integral part of the dam and operating under a normal head of 55 ft. The purpose of the project is stated as generation of electric power for public service and industrial use by the Aluminum Company.

• • •

Sherrill Appointed Manager At Cincinnati

Col. C. O. Sherrill, now president of the American Retail Federation and formerly city manager of Cincinnati at the time when the new charter first went into effect, has been appointed to serve again as city manager succeeding Clarence A. Dykstra who resigned recently to become president of the University of Wisconsin.

Colonel Sherrill, born in 1876, was graduated with honors from West Point in 1901 and served with the Corps of Engineers until his appointment as city manager of Cincinnati in 1926.

During the war he was in command of the 302d Engineers, served as chief of staff of the 77th Division, and later went to Germany as assistant chief of staff of the third Army.

Upon his return to the United States, Colonel Sherrill was placed in charge of fortification work throughout the United States and also acted as a member of the board of surveys and maps and of the interdepartmental board of Alaskan affairs. He was aide to President Roosevelt in 1903 and 1904 and chief military aide to President Harding from 1921 to 1925. In the latter year he was relieved of his duties to devote all his time to the direction of public buildings and public parks in Washington, D. C.

Since 1930, when he was succeeded at Cincinnati by Mr. Dykstra, Colonel Sherrill has been vice-president of the Kroger Grocery & Baking Co. and president of the American Retail Federation.

OBITUARY

CLARENCE E. FERREE, 63, civil engineer, died June 13 at O'Connors Landing, Ohio.

HENRY W. WOLF, 49, construction engineer and assistant supervisor of the Cleveland division of engineering, died recently in Cleveland.

GEORGE B. COUPER, head of the department of engineering of Montana State College at Bozeman from 1901 to 1909, died June 15 in Portland, Ore., at the age of 70.

SHIRL SQUIRE, 65, retired civil engineer of Seattle, died there June 15. A graduate of Purdue University, he practiced his profession for 24 years in many parts of the country.

ERASTUS G. SMITH, for 40 years head of the chemistry department of Beloit College, Beloit, Wis., died at Amherst, Mass., June 19, at the age of 82. Dr. Smith made studies in water filtration and contributed several papers to the water supply field.

CHARLES S. VOORHIES, civil and sanitary engineer, connected with the firm of Lockwood, Kessler & Bartlett, died June 20, in Brooklyn, N. Y., at the age of 73. Mr. Voorhies' work included many waterfront developments and the solution of the pollution problems of several bathing beaches in the New York area.

JOSHUA ATWOOD, 68, division engineer of the highway division of the Boston public works department since 1926, died there June 20. He graduated from the Massachusetts Institute of Technology in 1892 and later became executive superintendent of street clearing for Boston. In 1900 he was appointed assistant engineer of the Boston Elevated Ry. Co. in charge of track construction, later serving as assistant engineer for the Navy Department, Bureau of Yards and Docks, at Charlestown, Mass.

• • •

New Newark Terminal Put Into Service

The new Newark central terminal of the Pennsylvania R. R. went into service on June 20 after 8 years of construction.

The new terminal will combine under one roof the Newark passenger station of the Pennsylvania Railroad, the terminal of the Hudson & Manhattan Railroad (Hudson Tubes), a station of the new Newark subway, and a bus and trolley station.

The new terminal permits elimination of the Park Place station of the Hudson & Manhattan Railroad and of Manhattan Transfer, the interchange point for Pennsylvania uptown and downtown service in New York City.